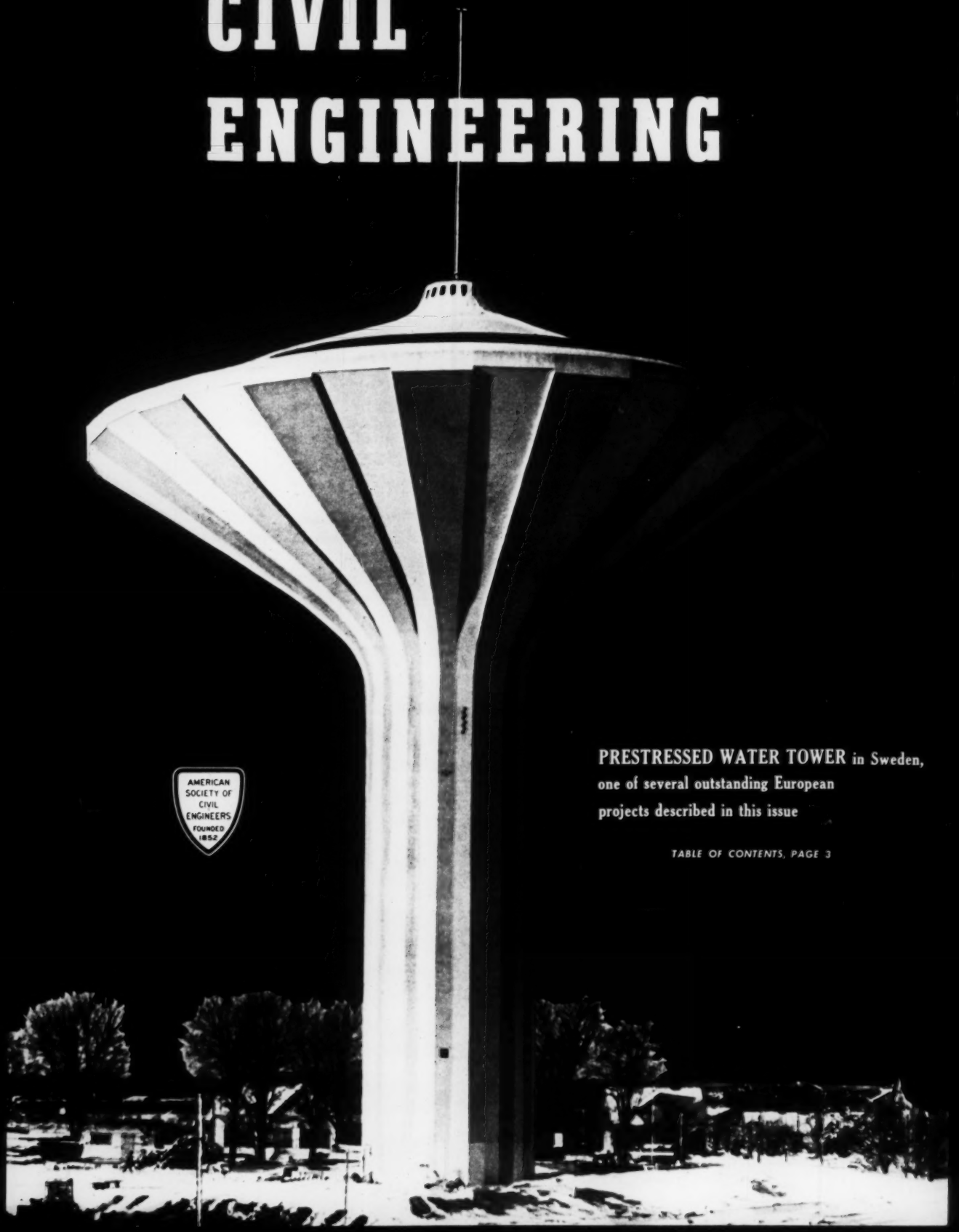
# CIVIL ENGINEERING



AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

**PRESTRESSED WATER TOWER** in Sweden, one of several outstanding European projects described in this issue

*TABLE OF CONTENTS, PAGE 3*

# 232,081 FEET OF RAYMOND PILES

## ...support the New Orleans Causeway Boulevard Interchange

If you have been away from New Orleans for the past couple of years you would hardly know the place now. The Crescent City is expanding . . . broad, gleaming expressways are shooting out in all directions. And Raymond is there, driving the foundations to support these important arteries.

The famous 24-mile Lake Ponchartrain Causeway, North Claiborne Industrial Canal Bridge, Broad Street Overpass and Wisner Drive Overpass are among the recently completed highway projects resting on Raymond foundations. The newest job for New Orleans' traffic alleviating program is shown above—the Causeway Boulevard Interchange over Airline Highway. It rests on 2,834 Raymond Step Taper Piles. In addition, on a third contract, Raymond is driving piles for another section of the Greater New Orleans Expressway which will connect Causeway Boulevard with the Mississippi River Bridge now under construction. Incidentally, the Mississippi Bridge Approach also is Raymond-supported.

If you, too, are planning a new expressway system, a single culvert, bridge or overpass—any highway project no matter how large or small requiring a pile foundation, investigate the advantages and economies of utilizing Raymond's 61 years of experience. You are cordially invited to write for Raymond's new Highway Brochure which explains how Raymond can help you and the National Highway Program. Write Dept. C-6, or contact your nearest Raymond office.

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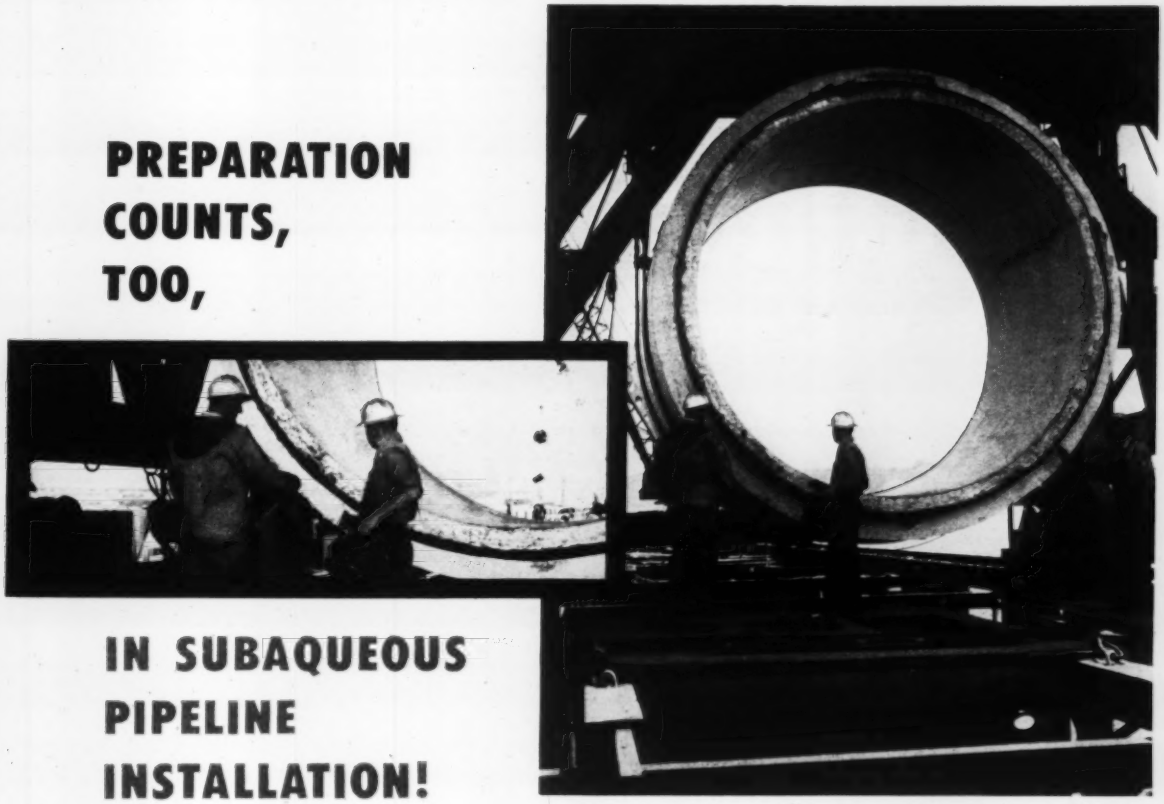

# IN SUBAQUEOUS PIPELINE INSTALLATION!

Sometimes buttoning up 60-ton sections of pre-cast concrete pipeline underwater in rough ocean swells, can get a little tricky — especially beneath the Pacific Ocean. That's where preparation and experience can mean the difference between success and catastrophic failure.

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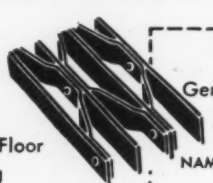

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# CIVIL ENGINEERING

OCTOBER 1958
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***THE MAGAZINE OF ENGINEERED CONSTRUCTION***

## • ARTICLES

*Editorial* 45 **One world of civil engineering**
*A. Lipski* 46 **Economical aluminum roof at Brussels World's Fair**
*David P. Billington* 52 **American engineer views concrete in Soviet Union**
*Staff report* 58 **Prestressed concrete units for Ivory Coast Bridge**
*Stephen M. Olko* 61 **Navy builds Port of Rota in Spain**
*Roger H. Corbetta, Hal W. Hunt* 64 **Harbor construction for U. S. base at Rota, Spain**
*Kurt Eriksson* 68 **Prestressed concrete water tower in Orebro, Sweden**
*T. Y. Lin* 74 **Prestressed slabs and shells—U. S. design and research**
*Ned L. Ashton* 78 **First welded aluminum girder bridge in Iowa**
*Thomas D. Y. Fok* 81 **Deflections of cantilever beam with variable section**
*Ernest L. Buckley* 82 **Reinforced concrete for lightweight stretch forms**
*Robert Schumacher* 83 **Improved type of grade-separated highway intersection**

## • SOCIETY NEWS

87 **PROGRAM of Conference on Electronic Computation**
89 **Ten new officers to be installed at Annual Convention**
93 **ASCE has three new Honorary Members**
94 **Award of prizes, a Convention feature**
97 **Tellers canvass ballot for 1959 officers**
*W. W. Moore* 98 **Why the UEC is important to you**
100 **U. S. engineers hosts to Congress on Large Dams**
*Milton Alpern* 102 **The Younger Viewpoint**
104 **Division Doings**
112 **By-Line Washington**

## • NEWS BRIEFS

116 **Dollar value of construction rises in August**
116 **Arctic construction studied at meteorological meeting**
118 **Aluminum in new form for bridges**

## • DEPARTMENTS

32 News of Engineers
36 New Publications
41 Am-Soc Briefs
43 Do You Know That
81 Engineers' Notebook
84 The Readers Write
108 Scheduled ASCE Meetings
122 N. G. Neare's Column
130 Deceased
136 Non-ASCE Meetings
140 Men and Jobs Available
141 Recent Books
142 Applications for Membership
143 Positions Announced
144 Catalog Digests
178 Index to Advertisers
**172 Proceedings Papers available**

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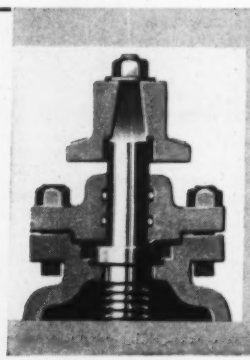
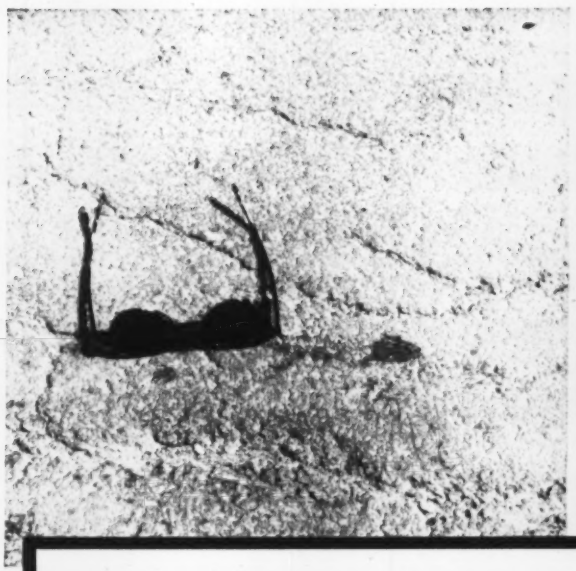


R. D. Wood Gate Valves also available with O-Ring Stuffing Box seal when specified.



# BITUMULS SLURRY SEALS ARE REAL LIFE SAVERS*

## For Pavements in Rochester, New York

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LEFT: A typical section of pavement to be treated with Bitumuls Slurry Seal in Rochester. RIGHT: The same pavement section after treatment with Bitumuls Slurry Seal. (Note how the crack in the foreground has been sealed).

The City of Rochester, New York, was faced with a problem common to many communities today: keep all streets maintained in serviceable condition; yet do it at a cost that will permit the complete replacement (out of Maintenance Department funds) of many miles of streets that are over-aged.

**Problem:** How can you keep overall maintenance costs low enough to permit planned replacement of certain streets?

**Answer:** Bitumuls Slurry Sealing . . . a "life saving" technique for keeping distressed pavements in "good working order". Streets that were badly oxidized, cracked and open-textured due to a combination of age, heavy traffic, and winter weather were readily rejuvenated by the sealing, crack-filling and void-filling properties of Bitumuls® emulsified asphalt slurry.

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Bitumuls Slurry Sealing is normally . . . and should be . . . regarded as only a **temporary treatment** for distressed pavements. Adequate repairs or pavement-replacement must eventually be made. Yet it is truly a "Life Saver", since it seals, protects and preserves any basically sound pavement against further deterioration until such a time as major repairs can be made, or the pavement can be replaced.

Typical view of the high-speed, high-efficiency Bitumuls Slurry Sealing in Rochester.

Your community, too, can benefit from the use of Bitumuls Slurry Seals. For further information on Slurry Sealing . . . or for the complete Bitumuls/Life Saver story . . . call our nearest office.

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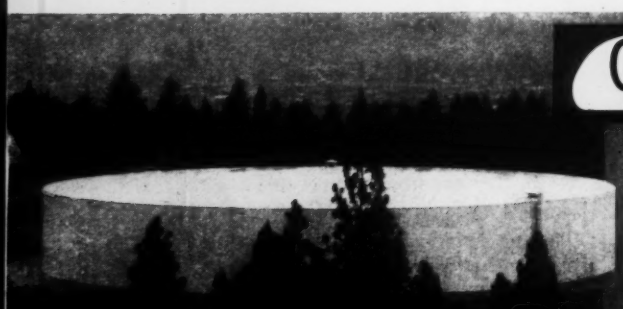
Write your nearest CB&I office for further details. Ask for the new bulletin: *Next Door Neighbor to Millions.*

**Above:** A 2,500,000-gal. Hortonspheroidal elevated tank blends attractively with landscape at Cincinnati, Ohio.

**Below:** 10,000,000-gal. Horton® reservoir helps to supply increased water needs at Spokane, Washington. Structure is 240-ft. in diameter.



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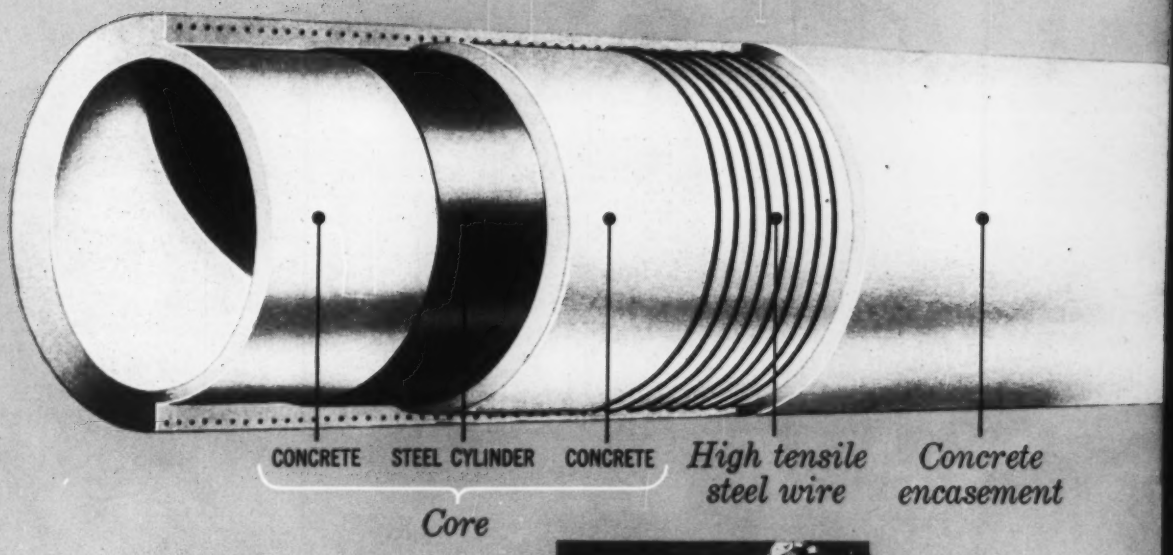


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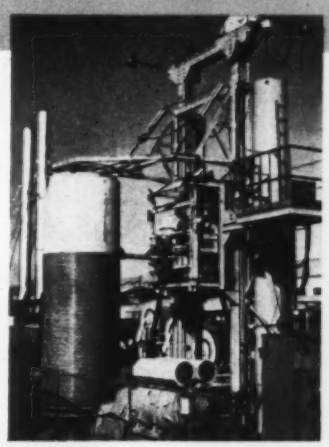
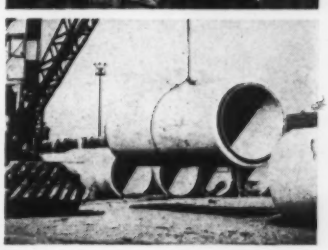


*Prestressing machine wraps high tensile steel wire under carefully measured tension around pipe core.*



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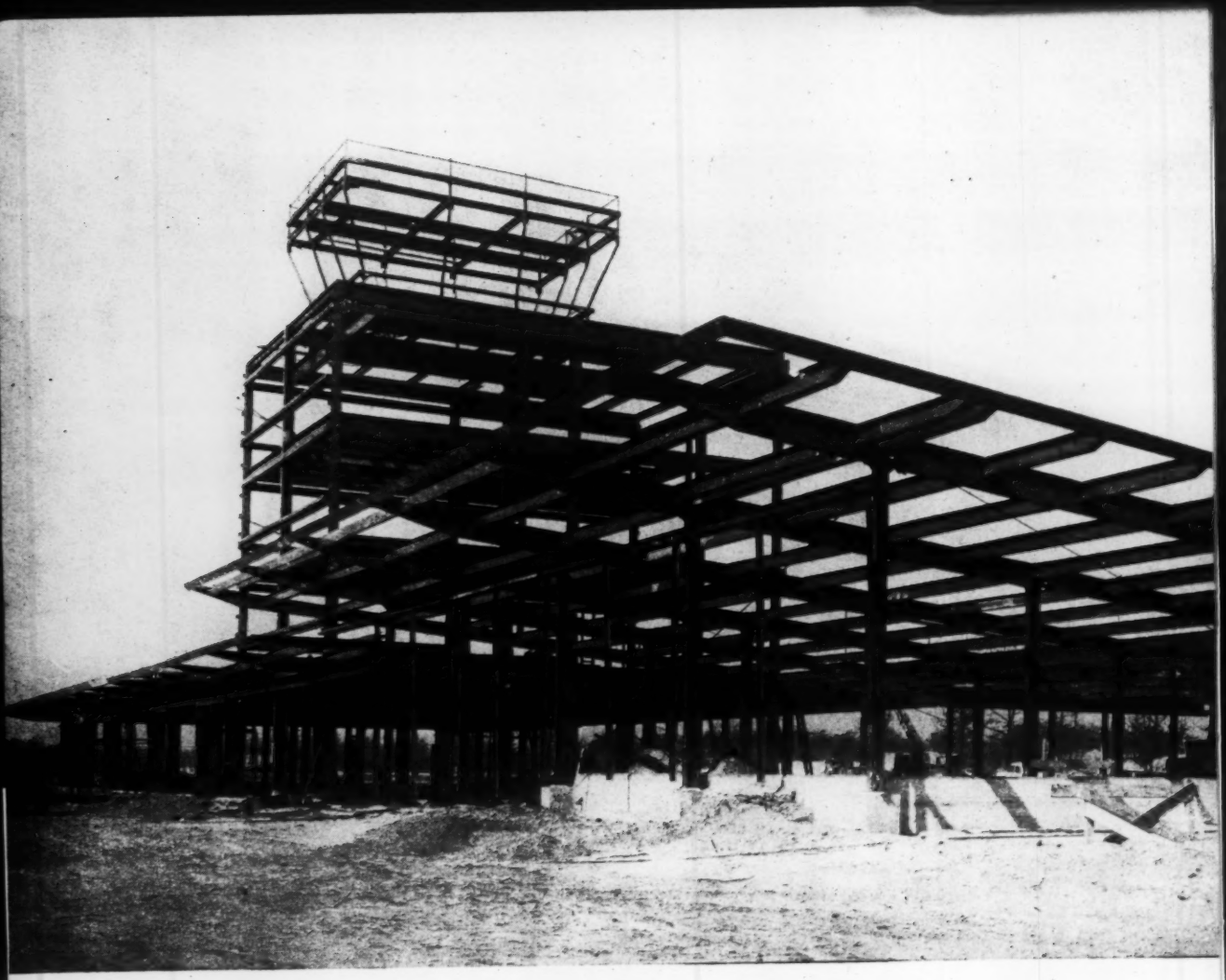
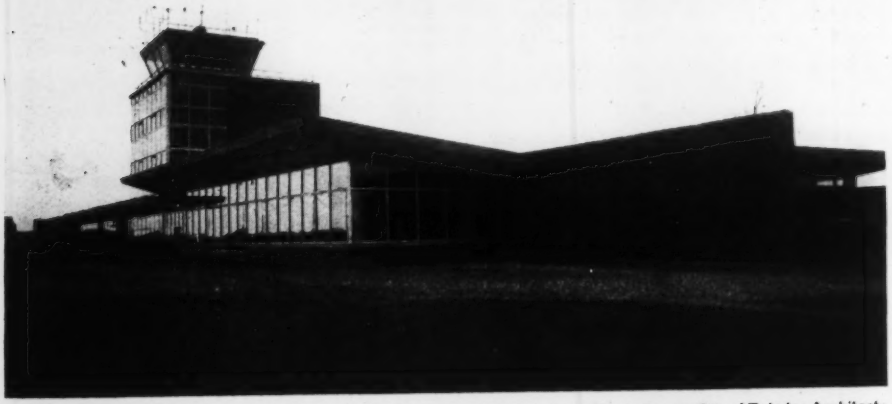


# USS Structural Steel from stock speeds



**Toledo Express Airport Terminal** fabricated with 225 tons of USS Structural Steel. Owner: City of Toledo; Architects and Engineers: Charles L. Barber & Associates, Toledo, Ohio; Consulting Engineers: H. A. Stepleton & Associates, Toledo, Ohio; Consulting Engineer: Porter W. McDonnell, Toledo, Ohio; Fabricator: Art Iron & Wire Works, Inc., Toledo, Ohio.

# construction of Toledo Express Airport Terminal

*This building had to go up in a hurry*—that's one of the main reasons it was framed with USS Structural Steel. The design was straightforward and clean, so the 225 tons of steel could be delivered directly from stock.

Shop connections were welded and field connections bolted. The rigid frame steel construction offers strength, safety, economy of erection and minimum maintenance. It also gave a lot of design freedom, for it simplified the application of glass panel exterior walls.

## Why it pays to use structural steel

- It is the *strongest*, yet *most economical* of load-bearing materials.
- Structural steel will withstand more abuse than other structural materials, effectively resisting tension, torsion, compression and shear.
- Once enclosed in buildings it lasts indefinitely—without maintenance.
- It can be riveted, bolted or welded . . . and erected in **any** weather.

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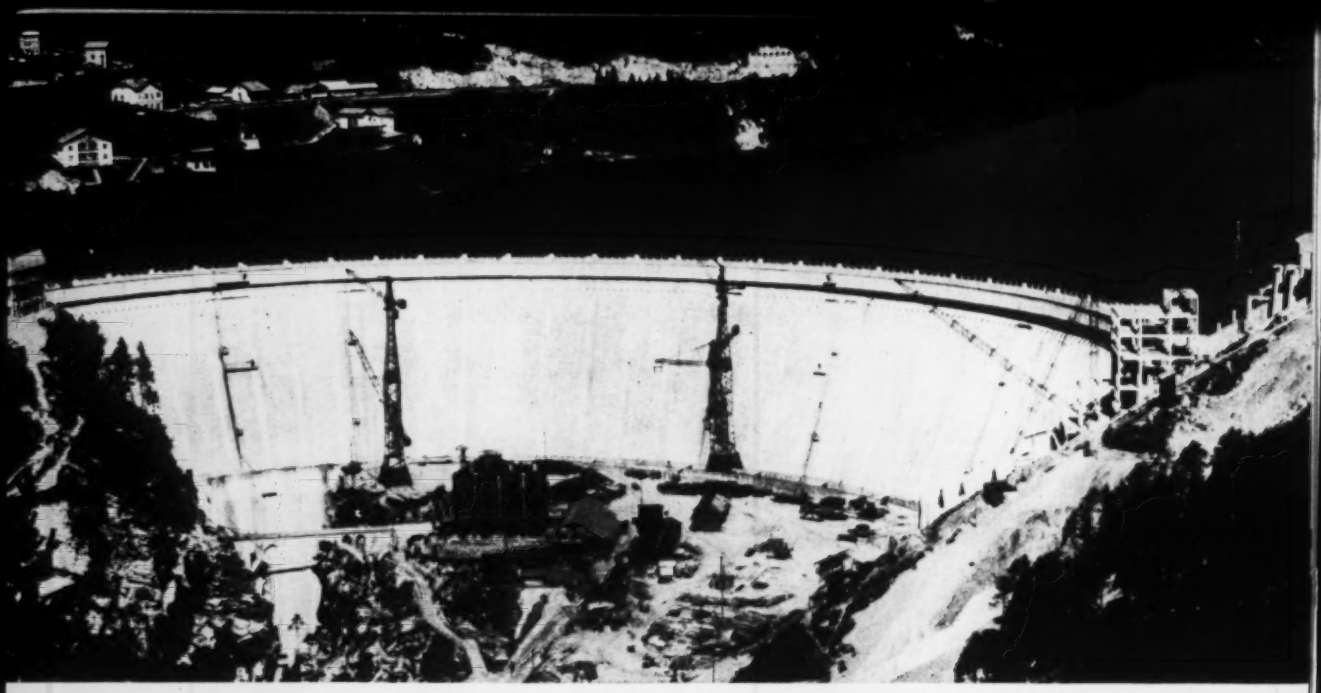

**Italy Dam of Pieve di Cadore, Province of Belluno** **1946-1948**

Arch gravity dam Max. height: 112 meters Length of crest: 410 meters Span: 308 meters

*Concrete*—494,000 cubic yards. A ferro-pozzolanic cement was used consisting of 75% portland cement and 25% pozzolana. The core concrete contained 338 pounds of cement per cubic yard. The face concrete on the water side contained 424 pounds of cement per cubic yard. Plastiment was added in the proportion of 1% by weight of cement throughout.

**OTHER DAM PROJECTS**

**Venezuela Dam on River Caroni** **1956-1959**

Gravity type dam Height: 30 meters Length: 180 meters

*Concrete* — 262,000 cubic yards with 4 fluid ounces of Plastiment liquid per bag of cement.

**Austria Limberg Dam—Kaprun Project 1948-1951**

Arch dam Height: 120 meters Length of crest: 350 meters Breadth of crest: 6 meters Breadth of toe: 40 meters

*Concrete* — 590,000 cubic yards. Mix contained 440 pounds of cement per cubic yard and 1 pound of Plastiment powder per bag of cement. Twenty-eight day compressive strength averaged 4250 psi.

**Italy Dam in Val Gallina** **1949-1951**

Arch dam Max. height: 92 meters Length of crest: 228 meters Span: 190 meters

*Concrete* — Mix contained 280 pounds of cement and 140 pounds of fly ash per cubic yard. Plastiment was used to assure good workability and specified compressive strength.

**Austria Dam of Salza** **1947-1948**

Arch dam Height: 50 meters Length of crest: 120 meters

*Concrete* — 36,600 cubic yards. Mix contained 458 pounds of cement per cubic yard and Plastiment. Plastiment was used throughout the later stages of construction to assure reaching specified compressive strengths.

**Switzerland Dam of Lucendro, St. Gothard** **1943-1947**

Buttress dam Height: 70 meters Length of crest: 270 meters

*Concrete* — 200,000 cubic yards. Face concrete on water side and crest concrete contained 458 pounds of cement per cubic yard and Plastiment powder 1% by weight of cement.

**Switzerland Dam of Sella, St. Gothard 1943-1947**

Gravity dam Height: 36 meters Length of crest: 300 meters

*Concrete* — 98,000 cubic yards. Face concrete on the water side contained 458 pounds of cement per cubic yard and 1% Plastiment powder by weight of cement.

**Algeria Dam of Beni-Bahdel** **1936-1937**

Multiple arched dam Height: Max. 57 meters Length of crest over arch: 220 meters

*Concrete* — Mix contained 508 pounds of cement per cubic yard and 1% Plastiment powder by weight of cement. Plastiment was added to improve strength and workability.

# Improve Your Concrete Dam Construction with SIKA PRODUCTS

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The improved placeability of low slump lean mixes is particularly noticeable with the addition of Plastiment. Compressive strengths are increased 15 to 25% making possible the most efficient use of portland cement. The initial set is retarded and rate of internal heat development is slowed down considerably.

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Plastiment is equally effective in the structural concrete made with smaller aggregate and higher cement content. Reduced shrinkage, increased strength, higher bond to reinforcing, and better surface finish are a few of the many advantages.

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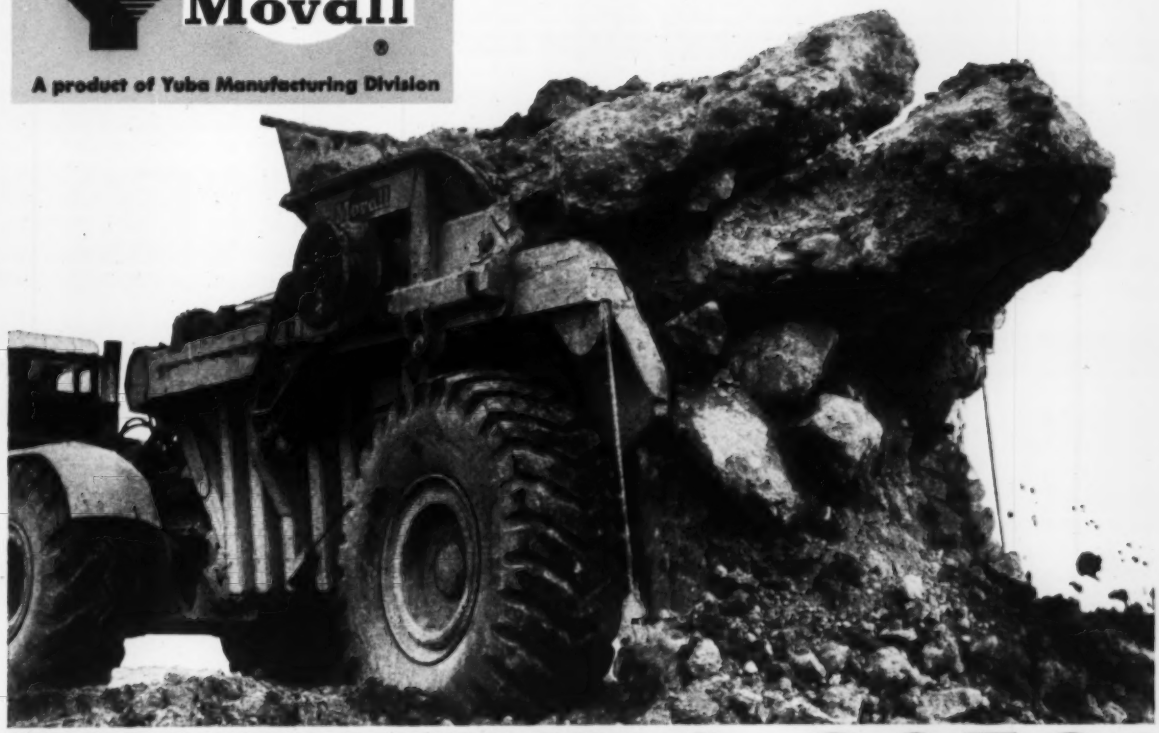

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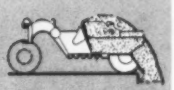
TAIL GATE UP

**DUMPING** — Level body offers no gravity resistance, with potential 140,000 lb. ejector push assuring complete positive discharge with minimum use of power.



TAIL GATE DOWN

**EMPTY** — Sides and bottom are scraped clean, eliminating need for "mucking out" or decreasing capacity for next full load. Complete ejection takes only 11 to 14 seconds.

TAIL GATE DOWN

## *140,000 pound push cleans out desk-size rocks or sticky clay—clean as a whistle in just 14 seconds!*

*The versatile, high-speed Yuba "Movall" outperforms rear and bottom-dump haulers on most every type of off-highway job!* Its powerful, positive ejector makes playthings of giant rock, frozen muck, or any other top loaded material. Bigger year 'round profits are yours with low-maintenance "Movalls" on the job. Check their unbeatable combination of features, such as high clearance, 180° turning radius, full stability in *all* operations, big tire flotation and traction, huge capacity. Get full information from your Allis-Chalmers, Caterpillar, or International Harvester Dealer, or contact *Yuba Manufacturing Division, Benicia, California,* today.

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Yuba designs and builds a wide range of equipment for engineered construction:

BRIDGES | BUILDINGS-STRUCTURAL | HYDROELECTRIC POWER | CRANES & HOISTS

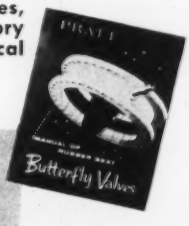
**Installation of 18" Pratt High Pressure Rubber Seat Butterfly Valve in prestressed concrete water main, Mansfield, Ohio. Engineers: Shaffer, Parrett and Associates.**

# *MANSFIELD* . . . Pratt Butterfly Valves meet all specs for distribution service

*The real test of a distribution valve is its ability to operate when needed.* Valves in water distribution service are primarily emergency measures, normally left either open or closed for months, or even years. Yet, they must operate when needed, often to prevent serious property damage in the event of a broken water main.

Mansfield engineers chose Pratt High Pressure Rubber Seat Butterfly Valves for this rigorous duty because Pratt valves meet all specifications for distribution service. The critical disc edge is a corrosion-resistant material, seating against a heavy, mechanically retained rubber liner to provide *permanent, drop-tight shutoff.* The stainless steel valve shaft rotates in bronze bearings, self-lubricated for life, and the valve operator is permanently lubricated and sealed. These features are your assurance of easy operation when you need it . . . features that are built into Pratt valves with the experience that comes with 30 years of leadership in butterfly valve design. Specifying Pratt valves puts this experience to work for you.

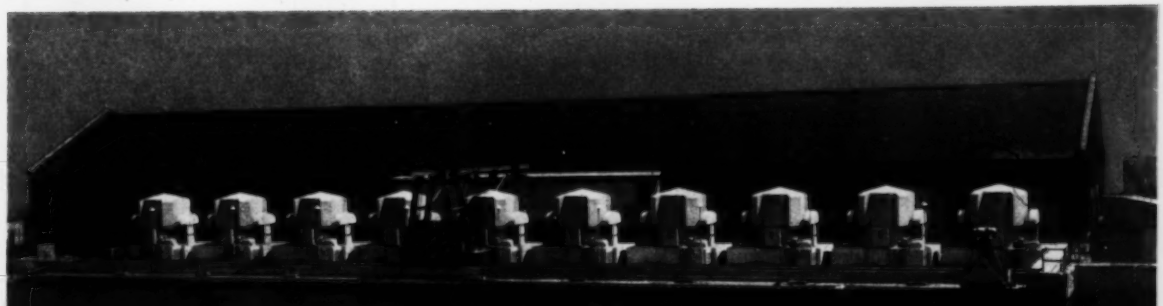
**NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information . . .**




HENRY PRATT

RUBBER SEAT Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities



# TEN LEFFEL TURBINES POWER THIS UNIQUE, OUTDOOR HYDROELECTRIC PLANT

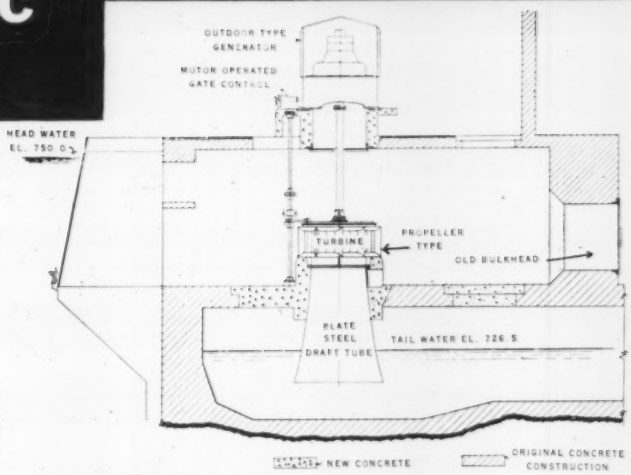
Another installation of efficient Leffel turbines is at the Lower Dam Hydro Plant, St. Anthony Falls, of the Northern States Power Company.

This plant is located a half-mile below the Falls of St. Anthony on the Mississippi River at Minneapolis, Minnesota. It was reconstructed in 1952 in cooperation with the Engineers Corps, Department of the Army's plan to extend the nine-foot navigation channel in the Mississippi River at Minneapolis.

The most feasible method for rehabilitation of the old plant was the installation of vertical, single runner units centered on the old multiple runner turbine settings outside the existing powerhouse. Unique steel housings, known as "Igloos", were used to protect the generator units from adverse weather conditions frequent in this upper Midwest area (Temperatures range from 105 to −30 degrees Fahrenheit).

By utilizing the existing structure in the rehabilitation of the Lower Dam Hydroelectric Plant, Northern States Power Company derived a modern, efficient plant at the lowest possible cost. Such savings are typical whenever and wherever efficient, creative engineering is put to work.

Leffel engineers have a full grasp of the theories and principles involved with *practical* hydroelectric power development such as this. And




*Each* of the 10 Leffel hydraulic turbines in the Lower Dam Hydro Plant is rated to develop 1160 H. P. under 23.5 Ft. net head, speed 225 R.P.M.

Leffel, with almost a century of experience, has the technical skill and production facilities necessary to produce turbines and related equipment of the highest quality, durability and efficiency.

If you're planning the rehabilitation or expansion of an out-dated plant, or the building of a new one, put Leffel technical ability and experience to work for you. There is no obligation.

Mail the coupon today for interesting, descriptive literature concerning hydroelectric power development.

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☐ Please send me more information on Leffel hydraulic turbines.

☐ Please have your representative call.

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Company _____

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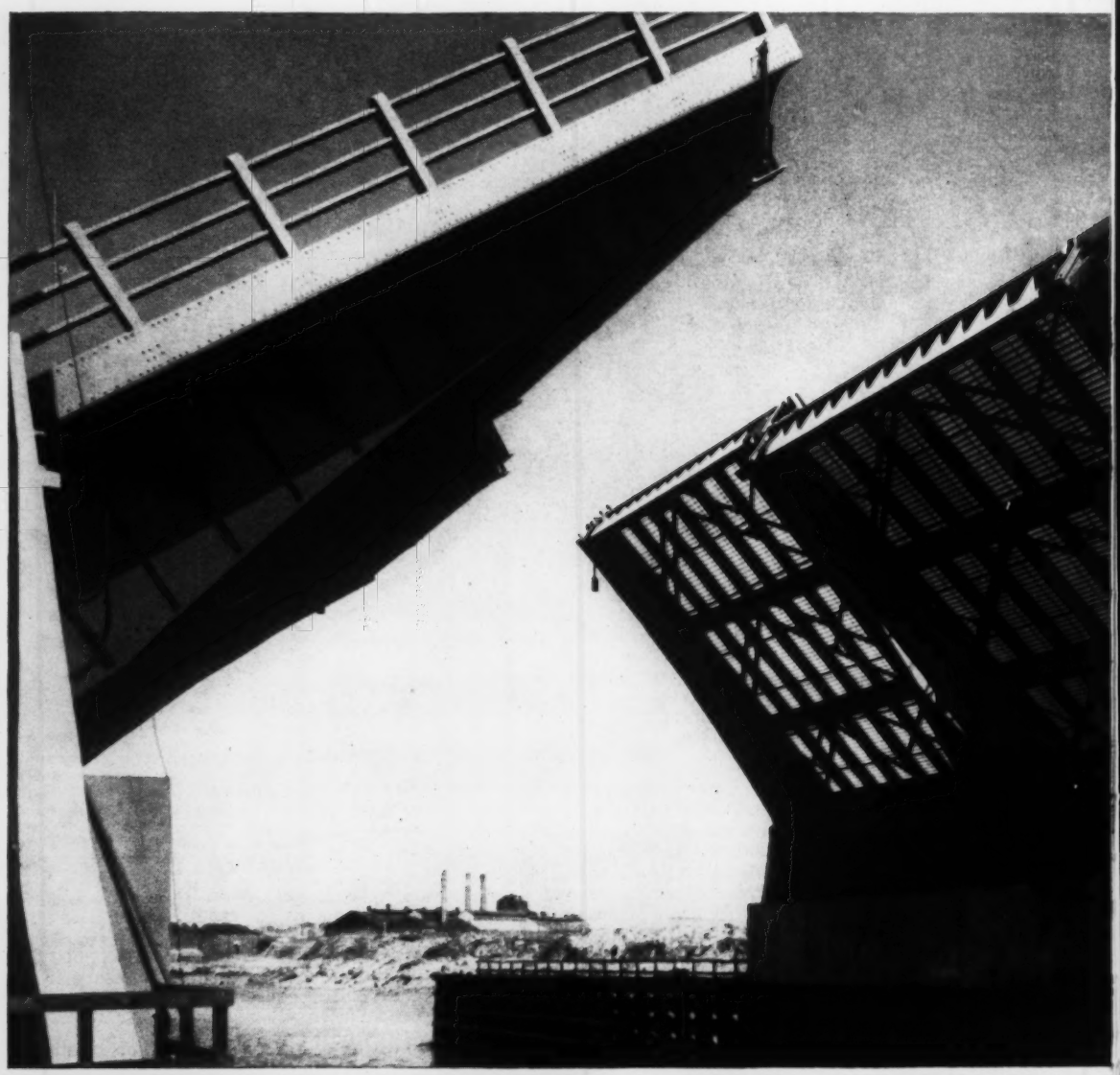
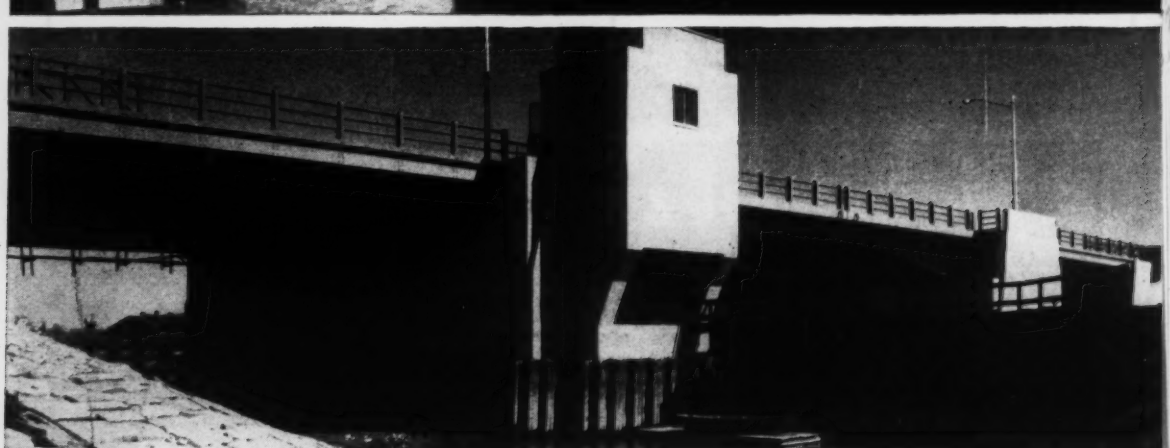
# On these double-leaf bascule spans





# AmBridge I-BEAM-LOK

## saves 202 tons!

**Conventional slab flooring on one leaf alone would weigh more than four I-BEAM-LOK floors**

**Nowhere** is weight-saving of greater importance than in movable structures—for every pound of extra weight not only adds to the cost of the supporting structure, but also increases the cost of operating and maintaining the bridge.

The Malden River Bridge, Everett, Massachusetts, is a good example of this fact. Fabricated and erected by American Bridge, this 257′-long bridge carries two 36′ roadways, two 6′ sidewalks, and a 4′ center mall on two double-leaf bascule spans.

A conventional slab flooring on the 6,270 sq. ft. of roadway would have added 263 tons of dead weight to the bascule spans, or 66 tons per leaf. The weight problem was avoided by flooring the movable spans with USS AmBridge I-Beam-Lok—6,161 sq. ft. of 5″ open type on the over-water portion and 109 sq. ft. of 3″ concrete-filled I-Beam-Lok on the parts covering the lifting mechanism.

With 5″ open I-Beam-Lok weighing only 18.8 pounds per square foot, and 3″ concrete-filled I-Beam-Lok weighing only 47 pounds per square foot, total floor weight was 61 tons—less than ¼ the weight of a conventional floor. 202 tons of dead weight was eliminated.

For detailed information about the time- and weight-saving advantages of USS AmBridge I-Beam-Lok—the modern flooring for today's heavy traffic—contact the office nearest you, or write direct to Pittsburgh. Ask for a copy of our 32-page catalog.

*USS, AmBridge and I-Beam-Lok are registered trademarks*

**The Malden River Bridge**
**Everett, Massachusetts**

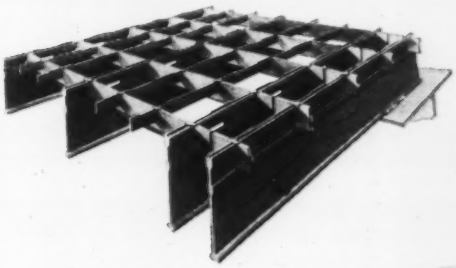
Owned by the Metropolitan District Commission, a subdivision of The Commonwealth of Massachusetts

Designs by Metropolitan District Commission and Charles A. Maguire & Associates

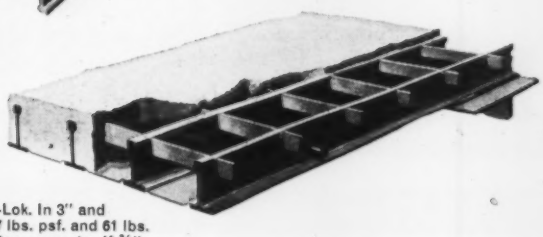
Supervising Engineers: Brask Engineering Co.

General Contractor: Munroe-Langstroth, Inc.

Fabricated and Erected by American Bridge Division of United States Steel



Open-type USS I-Beam-Lok. 5″ depth. Weighs 18.8 psf. Available in units 6′2″ wide and up to 48′ long. Can be applied directly to stringers.



Concrete-filled I-Beam-Lok. In 3″ and 4¼″ depths. Weighs 47 lbs. psf. and 61 lbs. psf. respectively including concrete. If ¾″ over-fill is used, add 9 lbs. psf. to above weights.

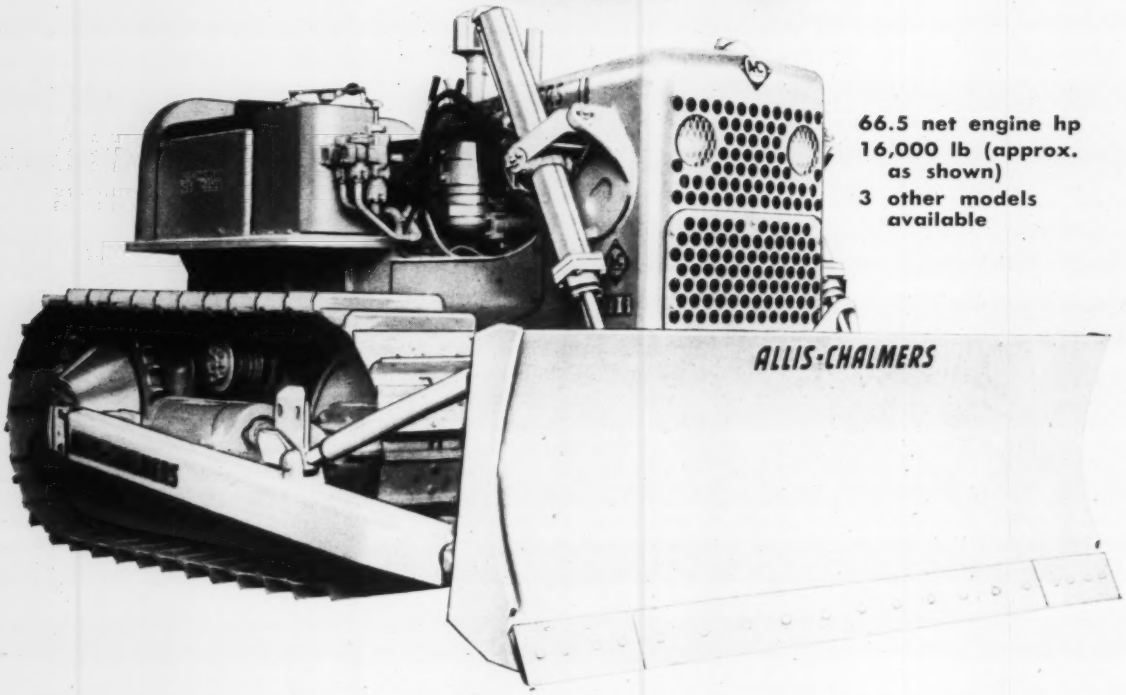
**American Bridge Division of United States Steel**

General Offices: 525 William Penn Place, Pittsburgh, Pa. Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati Cleveland • Dallas • Denver • Detroit • Elmira • Gary • Houston • Los Angeles • Memphis • Minneapolis • New York • Orange, Texas • Philadelphia Pittsburgh • Portland, Ore. • Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York

# POWER for the job

## PORTABLE without a permit

## ALLIS-CHALMERS HD-6 Dozer




**66.5 net engine hp**
**16,000 lb (approx. as shown)**
**3 other models available**

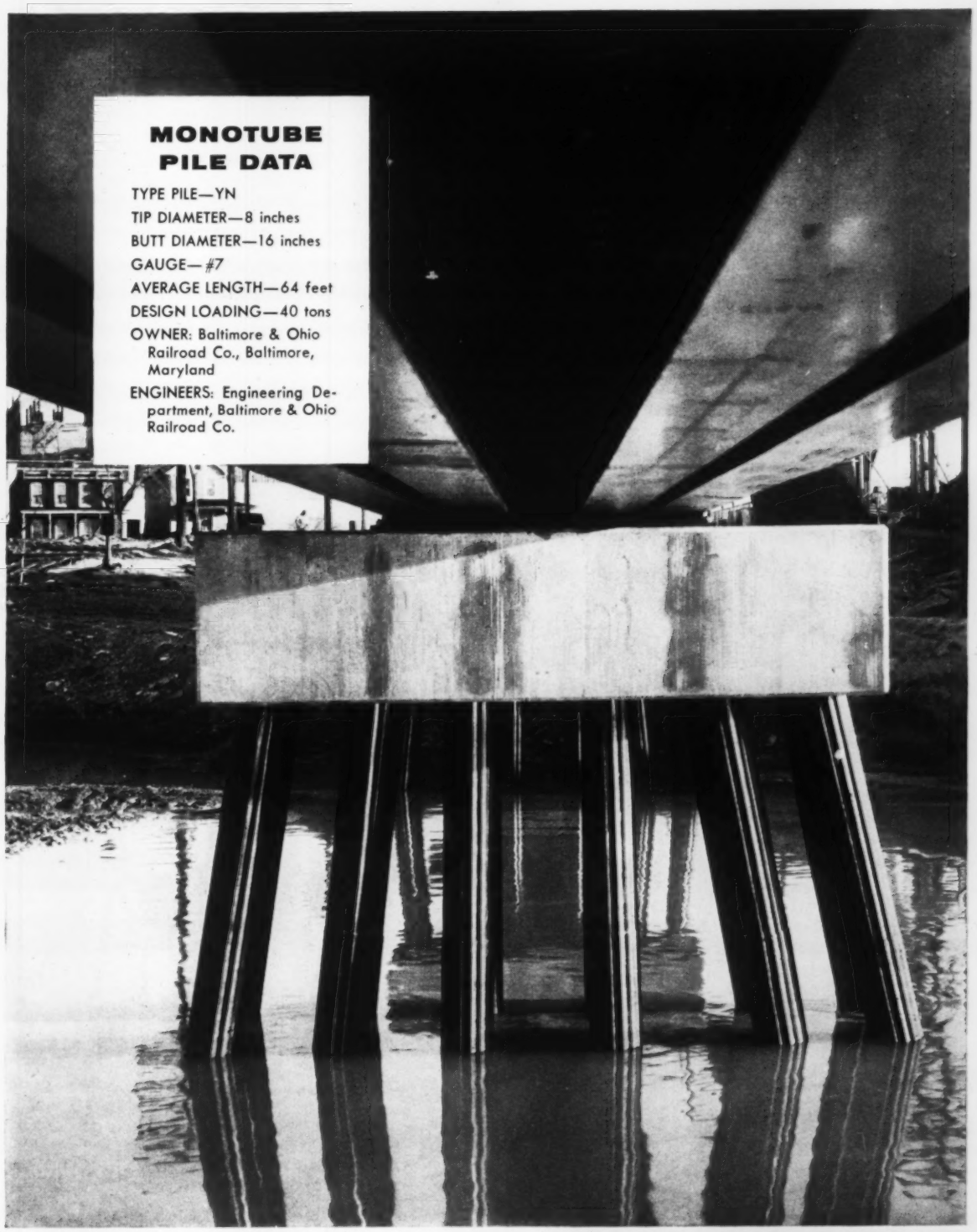
Contractors find the Allis-Chalmers HD-6 measures up — both in performance and easy transport. It has the size, power and dependability to make money on all your earthmoving jobs.

When traveling from job to job, there's no need to remove the dozer. The 8-ft. blade — legal width for highway travel — lets you load your HD-6 right onto a truck or trailer — travel quickly with no time lost.

The HD-6 is a maintenance man's tractor. Even in mud, sand, rock and dust, Allis-Chalmers Positive Seals protect tapered roller bearings on truck wheels, idlers and support rollers. These smooth-running assemblies require lubrication only once every 1,000 hours — change greasing time to profitable work time.

There are many reasons why more and more contractors are using HD-6 dozer tractors. See your Allis-Chalmers dealer. He'll be glad to demonstrate on your job. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

**Look ahead... *move ahead* ...and stay ahead with** **ALLIS-CHALMERS**




**DESIGN ECONOMY plus CONFIDENCE** with Monotube piles . . . a sizable saving over conventional pier design, yet complete conformity with railroad specifications. That's the record of these Monotube piles used by the Baltimore & Ohio Railroad at Westport, Maryland.

Tapered, fluted Monotube piles are available in lengths, diameters and gauges to meet every requirement. Write The Union Metal Manufacturing Co., Canton 5, Ohio, for complete information.

**UNION METAL**

*Monotube Foundation Piles*

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Just what the doctor ordered—an easier day's work. That means Tyton Joint® pipe. This ingenious pipe is a cinch to lay... anywhere, any time... even by inexperienced crews.

No need for bell holes or caulking... no nuts or bolts to fasten. Simply fit a specially designed rubber gasket

"NO HARD WORK FER A SPELL, LUKE... BUT YOU KIN STILL LAY TYTON."

U.S. cast iron PIPE

**FOR WATER, SEWERAGE AND**

# easy!

into the bell, and slide in the connecting pipe. The gasket insures a tight, permanent seal. And you can lay Tyton Joint pipe in wet trench or rain.

Call or write for complete details as to how Tyton Joint can save you time, money, trouble.

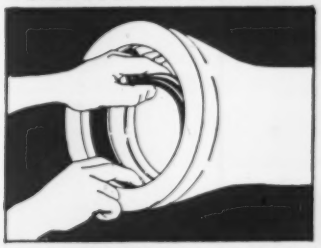
**U. S. PIPE AND FOUNDRY COMPANY**
**General Office: Birmingham 2, Alabama**

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE

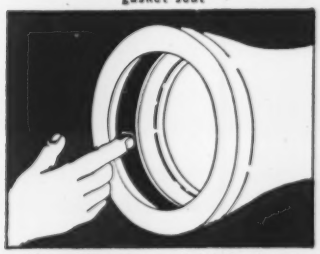
**INDUSTRIAL SERVICE** CAST IRON®

## TYTON

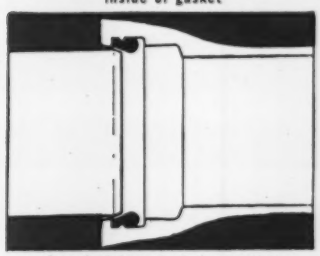
**ONLY FOUR SIMPLE ACTIONS**



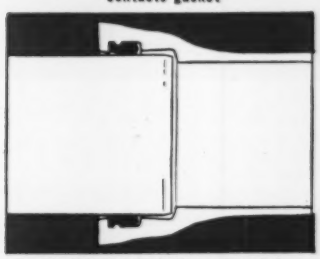
Insert gasket with groove over bead in gasket seat



Wipe a film of special lubricant over inside of gasket

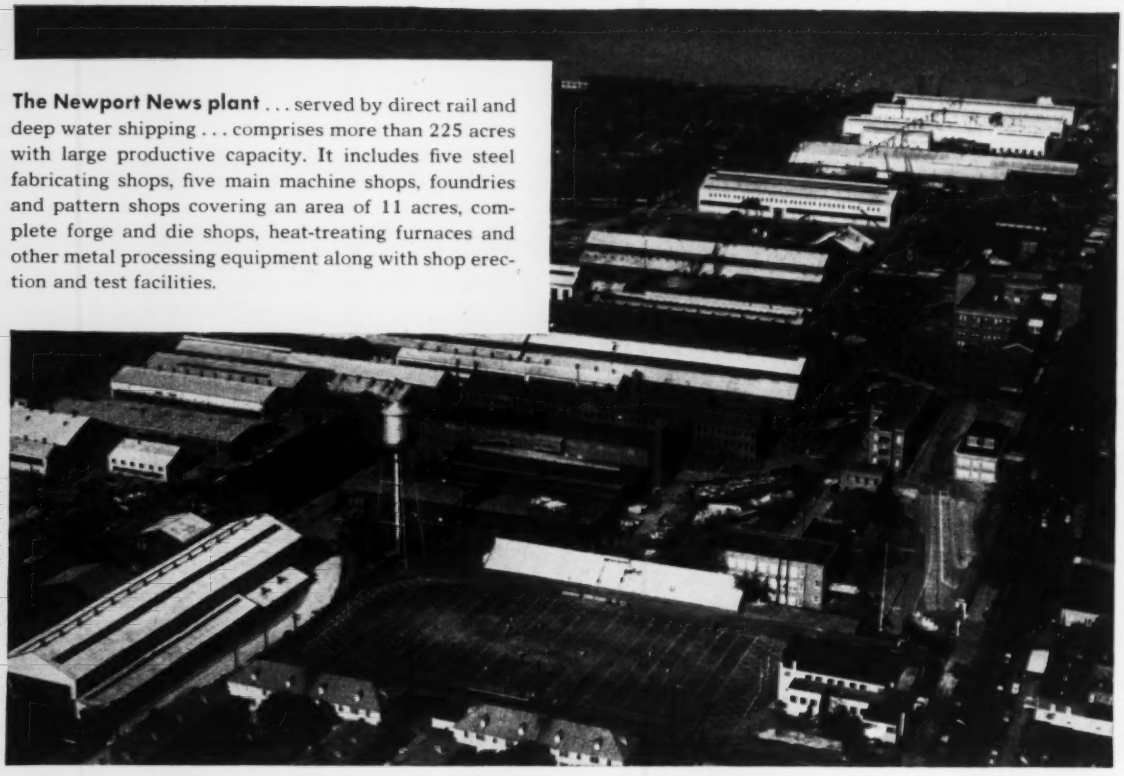


Insert plain end of pipe until it contacts gasket



Force plain end to bottom of socket... the job's done!

Tyton Joint pipe for water main extension in Oklahoma.



**The Newport News plant** . . . served by direct rail and deep water shipping . . . comprises more than 225 acres with large productive capacity. It includes five steel fabricating shops, five main machine shops, foundries and pattern shops covering an area of 11 acres, complete forge and die shops, heat-treating furnaces and other metal processing equipment along with shop erection and test facilities.

# Make Newport News your source for fabricated metal structures

Let Newport News fabricate your weldments or sub-assemblies. Call on us for plate fabrication . . . from vacuum tanks to bridge caissons . . . for pumps, valves, pipe lines . . . you'll find that Newport News fabricates parts to answer most demands.

In the vast plant, shown above, Newport News craftsmen complete your orders with specialized production techniques, and with sound experience acquired through construction of thousands of products ranging from small components on rayon spinning machines, to the giant 165,000 hp hydraulic turbines at Grand Coulee.

See for yourself what Newport News is doing, and how this company's high integration of skill and production facilities can help you. Get the facts, shown in *Facilities and Products.* A copy of this illustrated booklet is yours for the asking . . . write for it now.

**Newport News**
**Shipbuilding and Dry Dock Company**
*Newport News, Virginia*

# SPRAGUE & HENWOOD, Inc.—
# YOUR DRILLING AND SAMPLING CENTER

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**HIGHWAYS**
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**DAMS**
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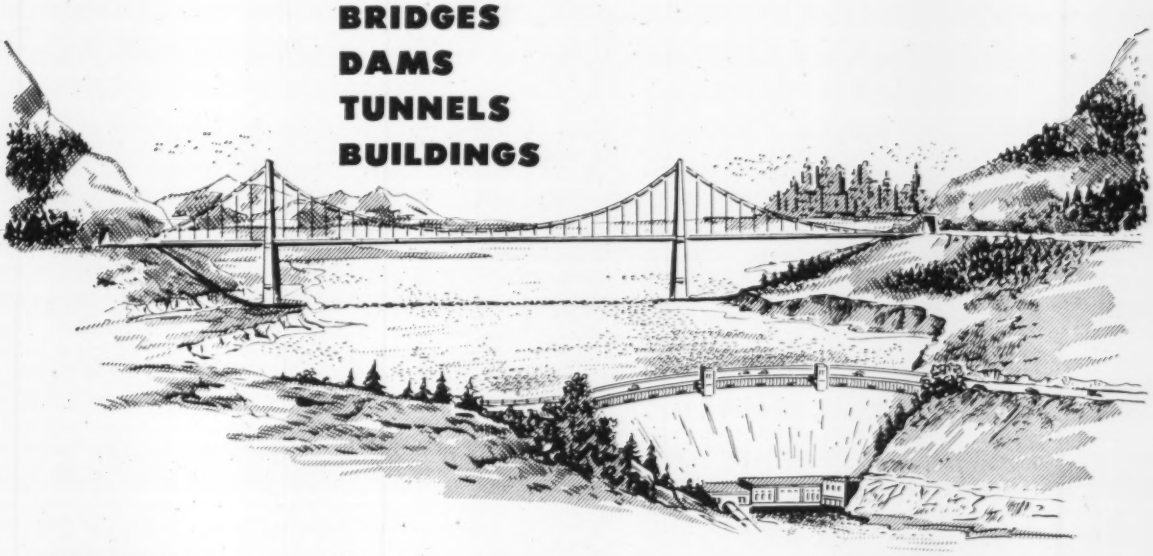
**BUILDINGS**



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*Core Drills . . . Soil Samplers . . . Pipe Driving Winches . . . "Oriented" Diamond Bits . . . Accessory Equipment*

The proper equipment is a necessary requirement for securing the accurate soil and rock samples needed to accurately determine the bearing capacity, etc. of penetrated strata. Sprague & Henwood has the most advanced equipment needed to perform this task. One such item is the new S&H Vane Shear Tester, which we believe to be the most accurate on the market today. It provides laboratory accuracy right in the field! The S&H Vane Tester and several other new sampling devices are introduced in the new Soil Sampling Bulletin No. 300. Write for your copy, now.

For drilling rock, ask about S&H modern, high-speed core drilling machines. For a lower cost per foot, always use Sprague & Henwood "Oriented" Diamond Bits.

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Longer bridges . . . Bigger dams . . . Taller buildings . . . Modern highways . . . all require more accurate foundation testing. Successfully designed projects depend largely on the unbeatable team of experienced drilling crews, modern drilling equipment, and expert drilling supervision. Sprague & Henwood has all three, assuring you accurate soil samples and rock cores whenever and wherever possible. Branches are staffed with experienced crews, stocked with modern equipment and are strategically located to give you fast, efficient service.

CALL, WRITE OR WIRE TODAY describing the sub-surface investigation you are planning! If you want to do the drilling and sampling yourself, we have the machines, samplers, accessory equipment and bits you'll need. If you don't want to purchase the equipment and do it yourself—we'll do it for you by contract.

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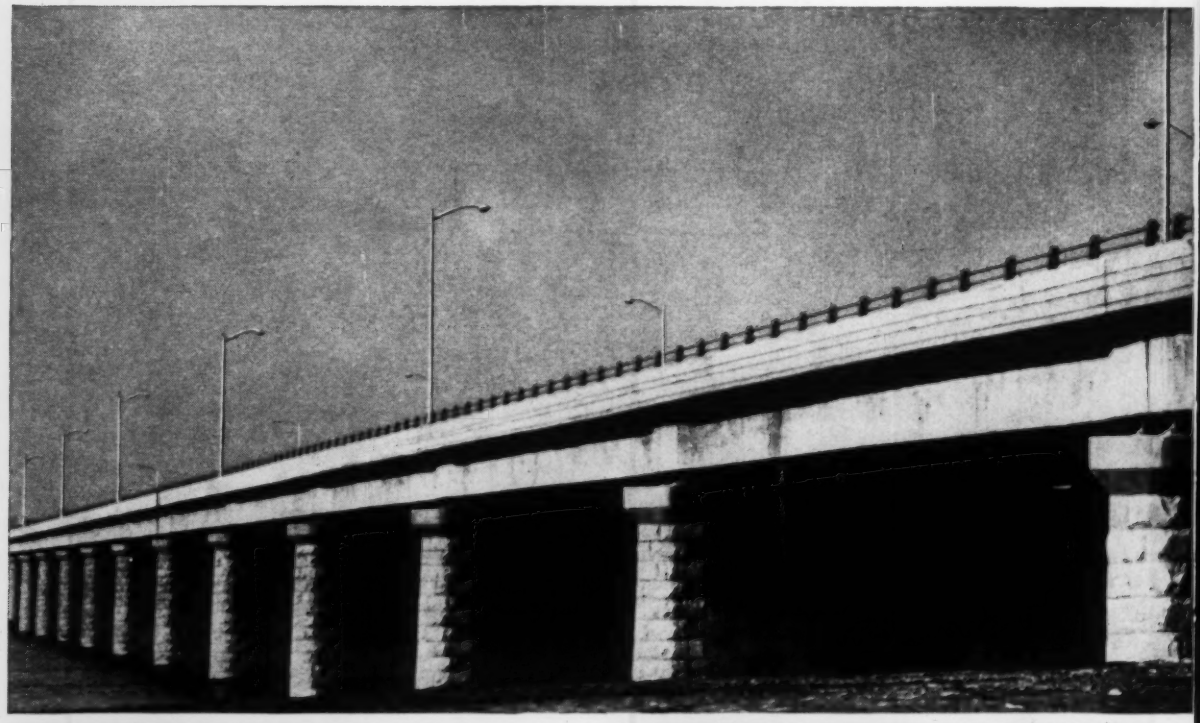
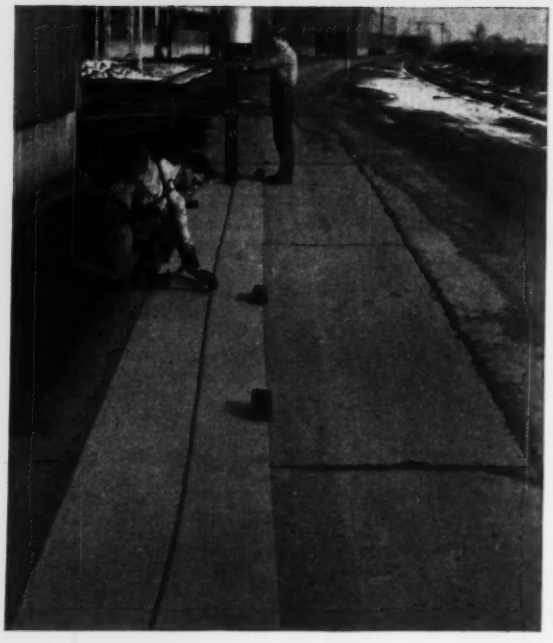
## On the Wolcott Avenue Bridge

# extraordinary straightness of new

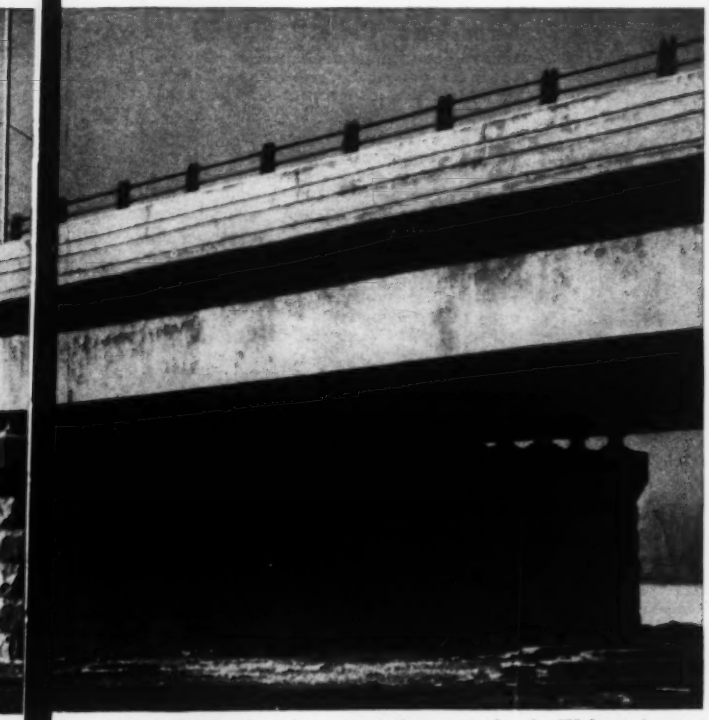




**Above**—This is a partially completed reinforcing assembly for girders in the Wolcott Avenue Bridge. Super-Tens Wires have been inserted in six of the twelve flexible metal tubes in this particular assembly.

**Left**—This photo emphasizes the superior straightness of USS American Super-Tens Stress-Relieved Wire as it is uncoiled. It stays straight and lies flat, with no tendency to curl, which greatly simplifies handling.

# USS American Stress-Relieved Wire solves on-site prestressing problem



**Fabrication of prestressed concrete** for the Wolcott Avenue Bridge was made much simpler through the use of *new* USS American Super-Tens Stress-Relieved Wire. Super-Tens is unusually *straight* prestressing wire. It stays straight . . . lies flat. This development has solved a major problem facing the manufacturer of prestressed concrete.

## 120-Foot Beams Prestressed Without Difficulty

**The Wolcott Avenue Bridge,** near Hartford, Connecticut, is a new cast-in-place, slab and girder bridge construction. It is built of concrete girders post-tensioned on the job with an amazing new product, USS American Super-Tens Stress-Relieved Wire.

This wire has straightness and handling ease never before realized in the field of prestressed concrete. New Super-Tens Stress-Relieved Wire developed by American Steel & Wire eliminates the tendency of wire to return to its original shape. This tendency has been a major problem in making up parallel-wire, post-tensioning assemblies. By using new, *straight* Super-Tens Stress-Relieved Wire, however, the builders of the Wolcott Avenue Bridge not only saved time on the prestressing operation, but did the job more efficiently.

Spans are 120 feet long; girder webs are seven feet deep and twelve inches wide. The Freyssinet post-tensioning system was used. Each cable contains twelve 0.276″ diameter USS American Super-Tens Stress-Relieved Wires.

Perfecting a straighter prestressing wire is the latest milestone for American Steel & Wire engineers, leaders in the application and development of steel wire and strand for prestressed concrete. If you are interested in prestressed concrete construction, get in touch with us today through our nearest Sales Office. Or write to American Steel & Wire, 614 Superior Ave., N.W., Cleveland 13, Ohio.

*USS, American and Super-Tens are registered trademarks*

**These are the people who built this bridge:**

**Owner:** The Greater Hartford Bridge Authority
**General Contractor:** Merritt-Chapman & Scott Corp., New York
**Designing Engineer:** Thomas Worcester, Inc., Boston
**Supervising Engineer:** DeLeuw, Cather & Brill, New York
**Consulting Engineer for Contractor:** The Preload Co., Inc., New York

**American Steel & Wire Division of USS United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

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## *Smith & Loveless* FACTORY-BUILT LIFT STATIONS AND SEWAGE TREATMENT PLANTS

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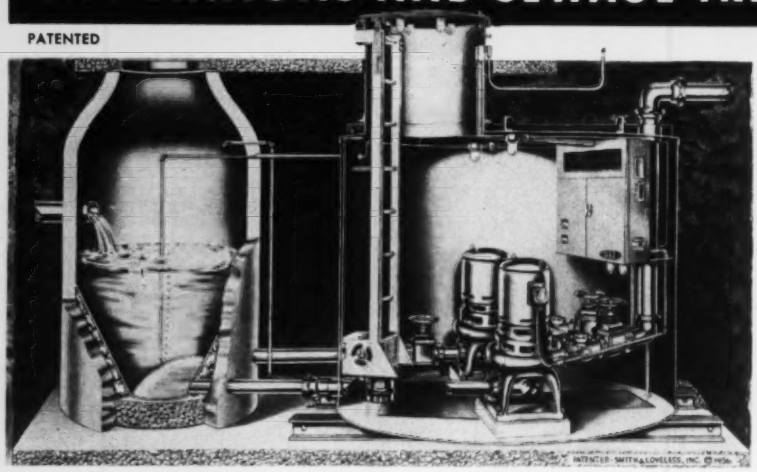
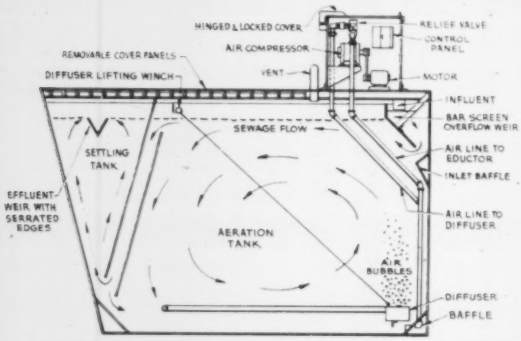


### AMERICA'S FINEST FACTORY-BUILT DUPLEX SEWAGE PUMP STATION

Today's finest pump station. Built from the most advanced design, by skilled factory-trained personnel, using quality materials and equipment.

Precision assembled, central electrical control cabinet prewired and color coded, dehumidified interior to prevent condensation. Pumps have pressurized mechanical seals. Low in initial cost and easy to install. Smith & Loveless stations are designed to provide maximum efficiency and long life with a minimum of maintenance.

Smith & Loveless offer a complete line of standard size factory-built lift stations with capacities up to 4500 G.P.M.



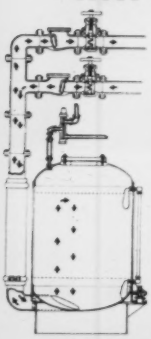

### *Smith & Loveless* "OXIGEST" SEWAGE TREATMENT PLANT

A high-quality, low-cost sewage treatment plant for sub-divisions, schools, motels and industrial plants. The "Oxigest" plant has been carefully engineered for dependable treatment without requiring the services of a skilled operator. Approved by F.H.A. and State Health Departments where submitted.

Built of the finest materials and properly reinforced to withstand interior and exterior pressures. The Smith & Loveless "Oxigest" will provide a permanent plant with minimum annual maintenance. Smith & Loveless also provide a complete line of "Sy-No-Seal" rotary distributors and other sewage treatment equipment.

*Write for Smith & Loveless "Oxigest" data manual with design notes, specifications, drawings, etc.*

### *Smith & Loveless* "WAY-O-MATIC"



FACTORY-BUILT

#### SEWAGE EJECTOR

Ideal for installations requiring 200 G.P.M. or less. The "Way-O-Matic" Ejector practically eliminates maintenance as the sewage does not come into contact with any of the controls. Built of finest materials to provide maximum performance at factory-built prices. The "Way-o-matic" may be ordered as a separate unit or in a complete lift station. Cutaway drawing shows operating principle.

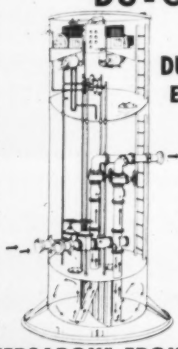
### *Smith & Loveless* "MON-O-JECT"

FACTORY-BUILT

#### SINGLE PNEUMATIC EJECTOR STATION

Designed for small installations of 200 G.P.M. or less. Completely automatic, extra large air storage. Requires minimum maintenance. Built of the finest materials and meeting the same high standards set by all Smith & Loveless lift stations. The "Mon-O-Ject" provides high-quality equipment for the modest budget. Requires minimum space underground. Cutaway drawing shows construction details.

### *Smith & Loveless* "DU-O-JECT"



FACTORY-BUILT

#### DUPLEX PNEUMATIC EJECTOR STATION

Most small sewage lift projects are served most economically and dependably by the Smith & Loveless "Mon-o-ject" single pneumatic sewage ejector lift stations. Where duplex equipment must be provided, the Smith & Loveless "Du - O - Ject" meets the requirements most economically. Cutaway drawing shows construction details.

**ALL S&L PRODUCTS ARE PERMANENTLY PROTECTED WITH S&L "VERSAPOX" EPOXY COATINGS**

MAKERS OF WATER AND SEWAGE TREATMENT EQUIPMENT

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*Smith & Loveless, Inc.*

P. O. BOX 8884 KANSAS CITY 15, MO.

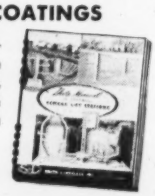
PLANT: LENEXA, KANSAS

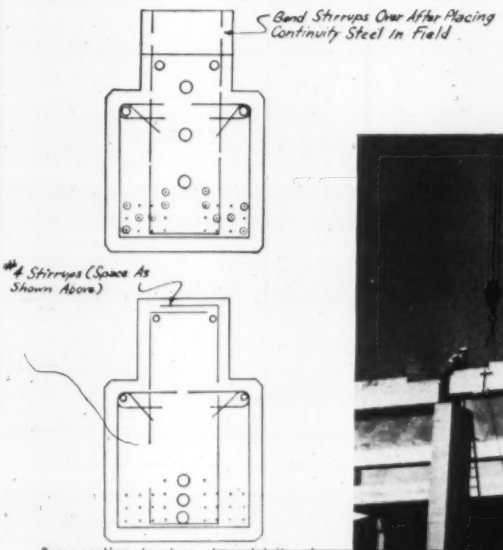
REPRESENTATIVES IN PRINCIPAL CITIES

For job recommendations, complete specifications, dimension drawings, capacity charts, etc., all part of the latest Smith & Loveless lift station data manual.

**WRITE DEPT. 80**

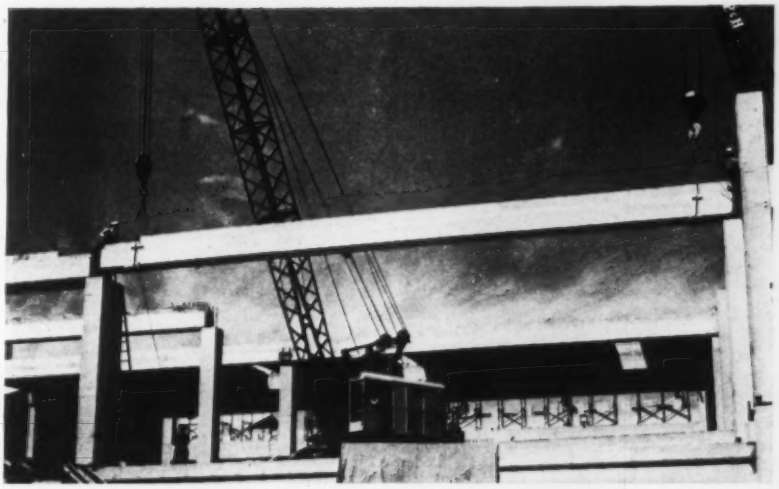
No obligation.





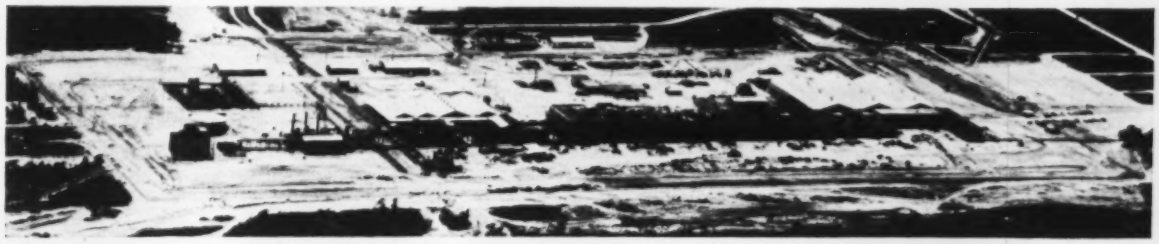

Cross-section drawings show details of typical 59-ft 8-in. inverted tee girder at one end and mid-span. The three Freyssinnet tendons, each with 18-0.196 in. dia. wires, were deflected to provide increased strength.

Prestressed concrete consultant: Ross H. Bryan, Consulting Engineer, Nashville, Tennessee.
Prestressed concrete manufacturer: Southern Prestressed Concrete Company, Inc., Pensacola, Florida.
General Contractor and prestressed concrete erector: J. A. Jones Construction Company, Charlotte, N. C.
Architect-Engineers: Lockwood Greene Engineers, Inc., New York, N. Y.



Here, prestressed concrete roof girder is lowered into place.

Aerial view of nearly completed plant. Entire facility covers an area of 1800 acres and will employ some 425 people.



# Main manufacturing building of $25,000,000 American Cyanamid plant built of prestressed concrete

American Cyanamid Company's New Creslan* Acrylic Fiber plant near Milton, Florida, is one of the world's most modern fiber production facilities.

The main manufacturing building is constructed of prestressed concrete. At peak production, this plant will turn out 27,000,000 lbs of Creslan fiber annually. The raw material for this synthetic fiber will be supplied by Cyanamid's plant in New Orleans.

Southern Prestressed Concrete Company, Inc., Pensacola, Florida, manufacturers of all prestressed members for the plant, in describing the main manufacturing building, stated: "The column spacing was uniform throughout at 25 x 60 ft; column heights varied over a range of from 13 to 33 ft. Because of the location in a coastal area, the structure was designed for a wind load of 40 psf. The roof deck was designed for uniform dead and live loads, and also for a number of concentrated loads. Special girder designs were used for the larger concentrated loads; each girder being 24 inches wide with heights from 36 to 40 inches. To reduce vertical height, the girders were inverted tee in shape, with the roof members resting on the ledge thus formed. The roof deck members are 14 inches deep by 4-ft wide double tees. Also furnished were floor and roof panels for a corridor of about 1000 ft in length. The entire job required over 2000 precast, prestressed pieces and about 100 miles of Roebling prestressed wire and strand."

This structure is one of the newer and bigger examples of prestressed concrete's ever-growing acceptance throughout the United States. In addition, it bears out Roebling's conviction that prestressed concrete is fast becoming a mode of construction with benefits that can only be considered impressive. Roebling's role in the prestressed field goes back to the introduction of the method in the United States. We invite inquiries of any nature on the subject of prestressed concrete. An inquiry to Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey, will bring a prompt reply.

*Creslan, Reg. T. M.

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*Branch Offices in Principal Cities*
*Subsidiary of The Colorado Fuel and Iron Corporation*

# DOLLAR

Ash disposal line for power plant in Alabama, being constructed with 12" Mechanical Joint Cast Iron Pipe.

**Big Business, too, chooses Cast Iron Pipe**

Fire protection line for large automotive plant in New Jersey, built with Mechanical Joint Cast Iron Pipe.

MODERNIZED **cast iron**

# FOR DOLLAR

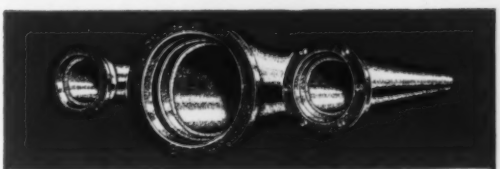
## Cast Iron Pipe delivers MORE water...LONGER!

Pipe is a capital investment.

But cast iron pipe is an investment that pays off.

- *In longer life* . . . cast iron pipe serves for centuries.
- *In more efficient operation* . . . cast iron pipe requires little or no maintenance or replacement.
- *In taxpayer satisfaction* . . . cast iron pipe far outlasts the bond issue that paid for it.

Most important to you, these statements are based on proof, not claims . . . performance, not promise. Specify cast iron pipe, America's most dependable pipe, and be sure, not sorry.



### 6 reasons why Cast Iron Pipe is #1 choice of U. S. A.

1. HIGH FLOW CAPACITY . . .
   Cement lined cast iron pipe and fittings will not tuberculate . . . delivers a full flow for the life of the pipe.
2. LONG LIFE . . .
   42 North American cities are still using cast iron water mains laid 100 years and more ago. Hundreds more have passed the 50 year mark.
3. BEAM STRENGTH . . .
   Cast Iron Pipe is inherently tough . . . stands up under heavy traffic load, soil displacement and disturbance.
4. EXTERNAL LOAD RESISTANCE . . .
   6" Class 150 Pipe withstands a crushing load of 17,900 pounds per foot . . . nearly 9 tons.
5. CORROSION RESISTANCE . . .
   Cast Iron Pipe effectively resists corrosion . . . vital factor in its long life and dependability.
6. TIGHT JOINTS . . .
   A full range of leak-proof, low cost, easy-to-assemble joints for pipe and fittings are available for all conditions.

THE MAN WHO CHOOSES CAST IRON PIPE TODAY WON'T PAY FOR IT AGAIN TOMORROW!

CAST IRON

Cast Iron Pipe Research Association
Thos. F. Wolfe, Managing Director
Suite 3440, Prudential Plaza, Chicago 1, Ill.

**pipe** FOR MODERN WATER WORKS

# contractor FORMS 130 ft. DIAMETER TANK 13 ft. HIGH IN 9 HOURS!

**ERECTION and STRIPPING COSTS—19¢ per sq. ft.!**

**Final Clarifier Tank**
**San Antonio, Texas**
**Sewage Treatment Plant**
**Curtis Hancock, Contractor**

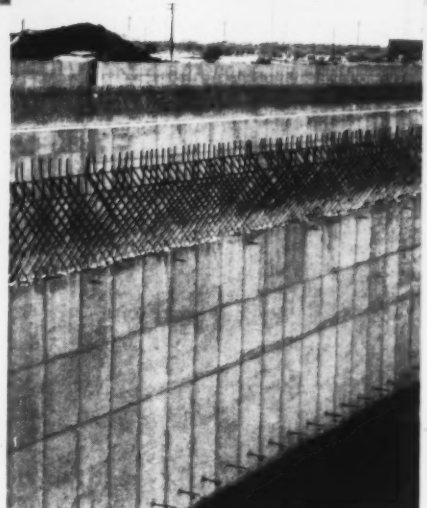
When a contractor can erect, align, and brace the forms for a 130 ft. diameter, 13 ft. high tank in *a single 9 hour day* — that's speed! And when *total costs* for erecting and stripping are only 19c per sq. ft. — that's economy!

This is the record of pre-fabricated UNI-FORM Concrete Panels used by Curtis Hancock in forming a final clarifier tank for the new 12 million dollar San Antonio, Texas sewage treatment plant expansion program.

In addition to UNI-FORMING the circular clarifier tank, Hancock used UNI-FORM panels to form four 30 ft. x 300 ft. aeration tanks, and a 1300 ft. concrete by-pass tunnel — approximately 135,000 sq. ft. of contact area in all.

In comparing the performance of UNI-FORM Panels on this job to a similar one done previously with forms he had built himself, Mr. Hancock estimates that he has saved at least four days in time alone!

It's performance like this that sells contractors and engineers on UNI-FORM panels. No other method of concrete forming can give you faster ground-to-ground forming speed, efficiency, flexibility, and economy. Why not investigate the advantages this modern concrete forming system can bring to you? Our strategically located Branch Offices and Distributors are ready to demonstrate and prove the advantages of UNI-FORM Panels to you. *Write for the new UNI-FORM Panel Catalog today.*



**UNI-FORMED walls are clean, require little or no finishing.**

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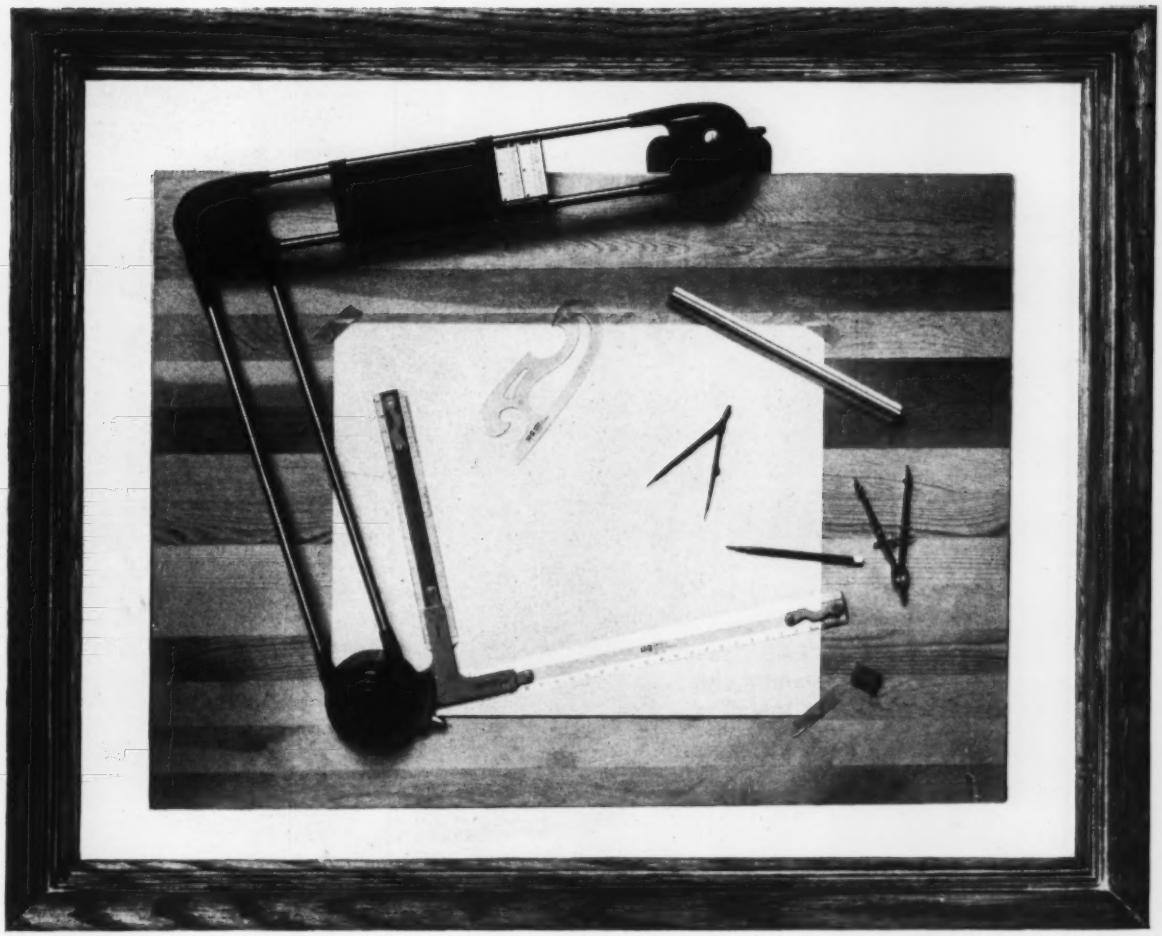

to complete the picture . . .

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When you are ready to put your project "on the boards". . . that is the time to have all the information about the many SONNEBORN BUILDING PRODUCTS at your fingertips.

SONNEBORN has for more than 50 years produced time-tested materials designed to protect, preserve and maintain such basic materials as wood, concrete, brick.

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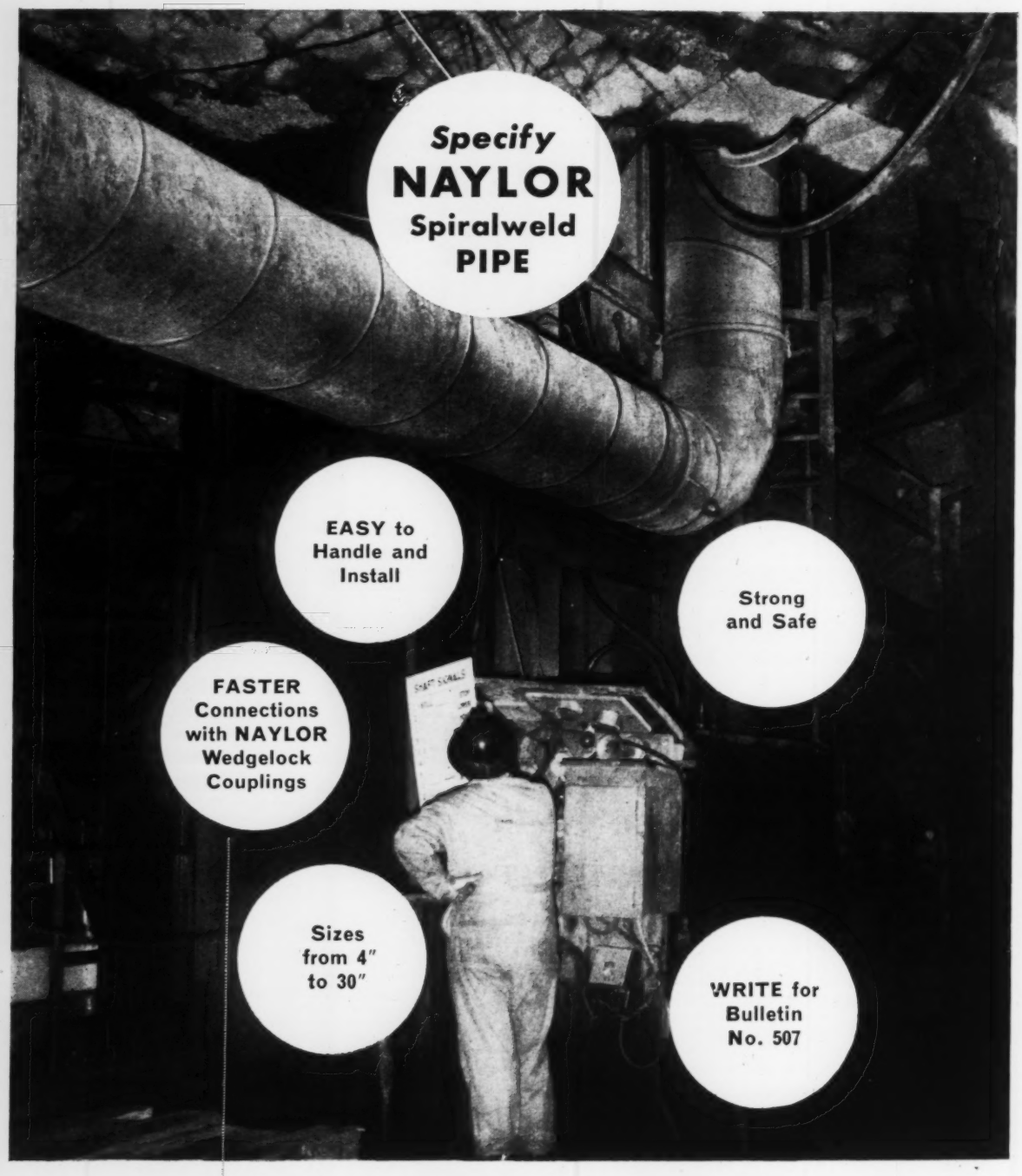


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FRANKI FOUNDATIONS

# 2 WAYS BETTER

## ...and this is Why

**1.** From a dollars-and-cents standpoint, Franki Displacement Caissons can mean savings of both time and money. Due to its different method of installation and resulting high working load capacity, *fewer units of shorter length are required.*

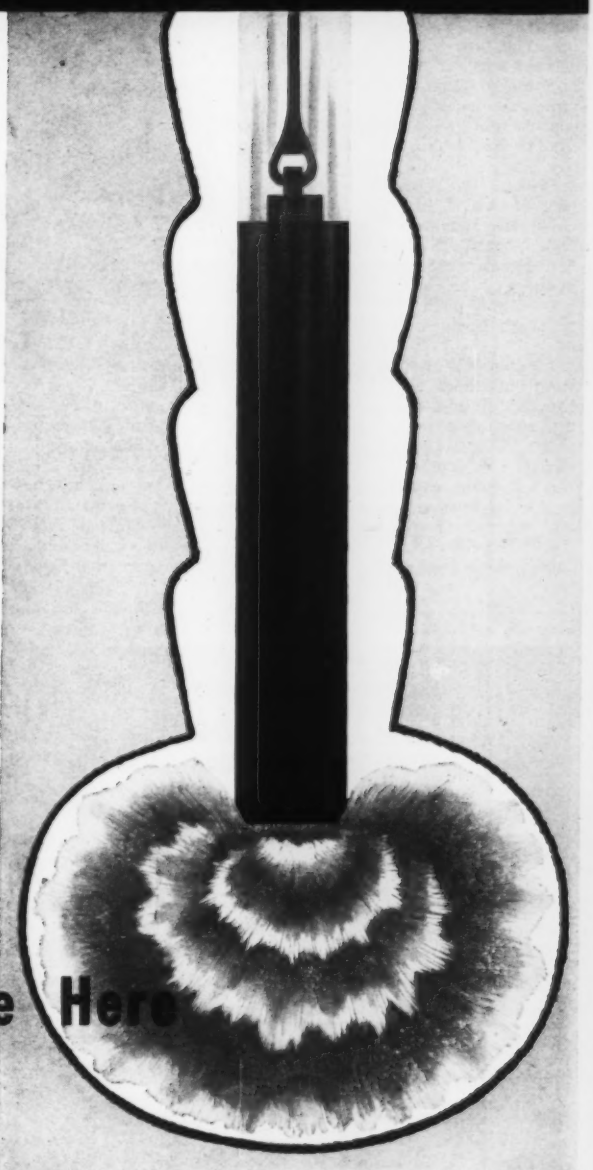
**2.** From an engineering standpoint, Franki Displacement Caissons take full advantage of the load carrying capacity of the soil. This is accomplished by ramming "dry"* concrete into the base, thus making in reality a pressure injected footing which, in turn, is surrounded by a compacted soil mass.

Unlike old-type or conventional pedestal piles, Franki bulb-like footings are "forged." Instead of poured concrete, they are made of "dry" concrete compacted by falling ram blows of approximately 140,000 foot pounds.

## The "DRY"* CONCRETE Makes The Difference Here

Before you draw up specifications for the next foundation, be sure to investigate the advantages of the *different* Franki Displacement Caisson. At your request, a Franki engineer will call to explain all details and show examples of how Franki saved both time and money on various projects. Write or phone.

*"Dry" concrete is defined as zero slump concrete using approximately 3½ gallons of water per bag of cement.



The high driving force of 140,000 foot pounds per blow of a falling ram, many times greater than the blow of a steam or of a pneumatic hammer, "forges" the different Franki injection type footing from "dry" concrete. It also compacts the surrounding earth to exploit the maximum bearing capacity of the soil.

**FRANKI FOUNDATION COMPANY**

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HAncock 6-0010

# NEWS OF ENGINEERS

**Bertram W. Goodenough** and **Glenn F. Sudman** will act as president and vice president of the newly established firm of Goodenough, Sudman and Overholser, Inc. The firm will offer complete engineering services from headquarters in Sacramento, Calif. The experience of the principals includes considerable heavy construction, and involves administration, project design, and field engineering.

**William H. Wisely,** Executive Secretary of ASCE, has been appointed by Governor Harriman to the eight-man New York State Public Health Council. Mr. Wisely will serve as the engineer member of the Council. According to law one member of the Council must be public health engineer.

**Lawrence W. Lane** and **Harry A. Edelstein** have been appointed associates in the firm of John J. Kassner and Company, consulting engineers of New York City. Mr. Lane, who will have the position of chief engineer, previously served the firm as assistant chief engineer. The new chief field engineer, Mr. Edelstein, was supervising engineer with the New York Department of Parks before he joined the Kassner firm.

J. A. Clema

**Joe A. Clema,** Colonel, Corps of Engineers, has taken over the responsibilities of District Engineer of the large Southern Italy District. Colonel Clema recently held the post of assistant for Air Force construction in Washington, D. C. A veteran of World War II and Korea, Colonel Clema will be responsible for the Corps in the southern part of Italy as well as Sicily, Greece, Turkey, Crete, Libya, Morocco and Eritrea.

**Robert L. Moore** has been elected an assistant secretary of the Lumbermens Mutual Casualty Company and the American Motorists Insurance Company. The announcement is made by J. S. Kemper, chairman of the boards of both companies. Mr. Moore has been with the Kemper companies since 1951 and, before his recent appointment as superintendent of engineers, was director of the technical and engineering division of the Safety Engineering Department.

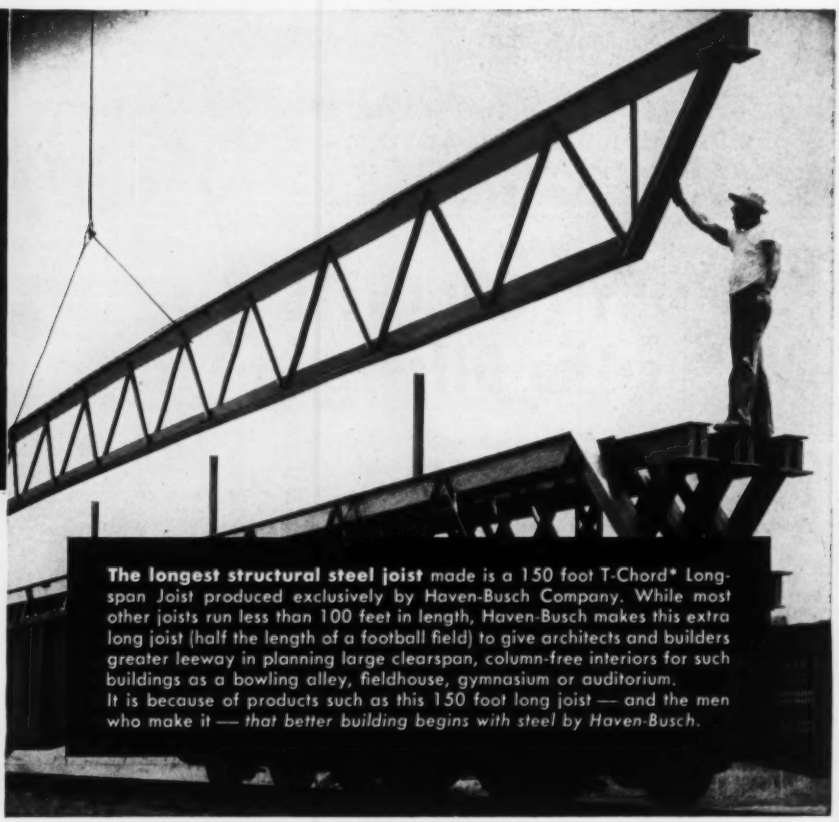
**Abba G. Lichtenstein** and **Herbert Storch** have been named associates in the engineering practice of Goodkind and O'Dea, with offices in Hamden, Conn., Bloomfield, N. J., and New York, N. Y. Mr. Lichtenstein formerly was principal bridge engineer with the firm, and Mr. Storch held the position of associate partner.

**Howard Simpson** was recently honored by the Massachusetts Institute of Technology with the honorary degree of doctor of science in Civil Engineering. The Boston Society of Civil Engineers has also honored Dr. Simpson with the Desmond Fitzgerald Medal which he received for his paper, "The New ACI Code —Its Implications and Ramifications." Dr. Simpson is a member of Simpson, Gumpertz & Heger, Inc., consulting engineers of Cambridge, Mass.

**David R. Loheit,** has become administrative assistant for the Hinchman Corporation, specialists in corrosion control, with offices in Detroit, Mich. Mr. Loheit is a recent graduate of the University of Michigan.

*(Continued on page 34)*


HOW LONG IS A LONGSPAN JOIST?



**The longest structural steel joist** made is a 150 foot T-Chord* Longspan Joist produced exclusively by Haven-Busch Company. While most other joists run less than 100 feet in length, Haven-Busch makes this extra long joist (half the length of a football field) to give architects and builders greater leeway in planning large clearspan, column-free interiors for such buildings as a bowling alley, fieldhouse, gymnasium or auditorium.
It is because of products such as this 150 foot long joist — and the men who make it — *that better building begins with steel by Haven-Busch.*

HAVEN-BUSCH Company
SINCE 1888

DESIGNERS — FABRICATORS — ERECTORS

T-Chord* Longspan Joists Structural Steel

Miscellaneous Iron

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*T.M. Reg.

Exclusive "Executive House" in downtown Chicago . . .

## country's tallest concrete frame and floor building rises 40 stories in 371 feet!

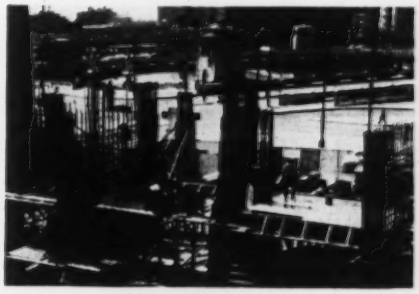
WHEN AMERICA BUILDS FOR THE FUTURE...
IT BUILDS WITH CONCRETE

This impressive $6,000,000 building with its 446 apartments brings luxury living to Chicago's business district.

On the 100 ft. x 150 ft. lot, space was at a premium. To make the most of it, architects Milton M. Schwartz & Associates, Inc., and the Miller Engineering Company, both of Chicago, chose *concrete*. With it, apartments are big . ceilings a full eight feet. Yet floor to floor height is only 8 ft. 10½ in. Plaster is applied directly to the concrete.

And concrete saved money—an estimated $500,000. It saved time, made easier scheduling, too. Concrete's always ready on short order.

Executive House sets a U.S. height record for concrete. Today, for high-rise buildings and monumental structures, more and more architects and engineers are turning to concrete.



**Four concrete shear walls** extending across the width of the building provide necessary resistance to wind forces.

FOR STRUCTURES... MODERN **concrete**

**PORTLAND CEMENT ASSOCIATION**

*A national organization to improve and extend the uses of concrete*

## NEWS OF ENGINEERS

(*Continued from page 32*)

**Thomas Airis,** director of construction and administration on the multi-million-dollar St. Lawrence Seaway, has received an award from the federal government for Sustained Superior Performance as area engineer on the Seaway Project. Working on an accelerated time schedule of three and a half years, Mr. Airis received the award for "overcoming the complex and unusual engineering problems that developed during construction."

R. L. Nordlund

**Raymond L. Nordlund** has been assigned to the post of soils engineer and consultant in the New York office of Raymond International, Inc. Mr. Nordlund previously served the Raymond Concrete Pile, Ltd., as manager of the Vancouver, B. C., office. He joined Raymond as a field engineer after graduating from the University of Illinois with a Ph.D. in foundation engineering.

**Charles L. Hall,** retired Colonel, Corps of Engineers, has been unanimously elected to honorary membership on the Permanent International Commission of the Permanent International Association of Navigation Congresses. Colonel Hall has been in retirement for ten years after serving for 40 years, mostly in connection with the civil works programs assigned to the Army Engineers.

**John J. Theobald** became superintendent of schools for the New York City Board of Education on September 1. Mr. Theobald succeeds William Jansen who has retired. A civil engineering graduate of Columbia University, Mr. Theobald has served as president of Queens College and, since 1956, has been Mayor Robert Wagner's deputy. Mr. Theobald, who has no degree in education, is a phenomenon in the field. As one of his important duties in his new job, he plans to attempt to raise the IQ of New York City school children.

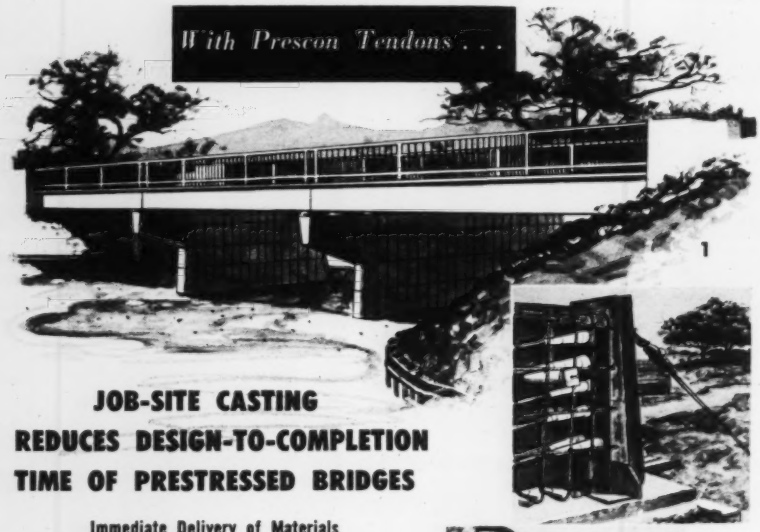
**Roger B. McWhorter** has retired as chief engineer of the Federal Power Commission, Washington, D. C., after many years in government service. He will make his home in Decatur, Ala., where he will continue to work as a consultant. Mr. McWhorter is one of the United States representatives on the International Joint Commission.

**A. R. Curtis** has been named manager of the asphalt sales division of the Esso Standard Oil Company. Mr. Curtis, who has been in asphalt marketing during his 21 years with Esso, served as assistant manager of the division in 1956 and recently has been acting manager.

**James D. Bucher** and **Shelby K. Willis** announce a change of address for the consulting office of Bucher and Willis. The new office is located at 629 East Crawford Street, Salina, Kans. The firm offers consulting service in roadway and bridge design, urban planning and expressways and structural services for buildings.

**Edmund Young** has joined Concrete Industries, Ltd., of Australia, as civil engineer for southeast Asia. He is engaged in an executive engineer training program learning the company's operations. The company is planning to extend its operations to Malaya, Borneo, Hong Kong, Singapore and Ceylon.

**Gerald E. Galloway** and **Keith R. Barney,** both Major Generals in the Corps of Engineers, have recently been transferred to new assignments in the Corps. General Galloway will be commanding general at the U. S. Army Engineer Center at Fort Belvoir, Va. Since 1956 he has been division engineer in the Missouri River Division. General Barney will succeed General Galloway as Missouri River Division Engineer. For the past three years he has served as director of installations in the Office of the Deputy Chief of Staff for Logistics, Department of the Army, Washington, D. C.


**JOB-SITE CASTING REDUCES DESIGN-TO-COMPLETION TIME OF PRESTRESSED BRIDGES**

**Immediate Delivery of Materials Important Factor in Early Completion**

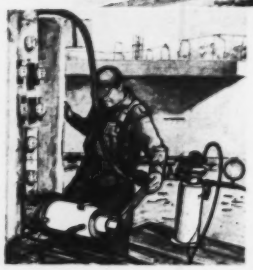
Highway departments in several states have already completed a number of prestressed highway bridges utilizing the Prescon System of post-tensioning.

For the contractor, use of the Prescon System assures tendons delivered to the job site, completely assembled, clearly identified and ready for the forms; a Prescon representative to instruct his men in placing and stressing the tendons, using stressing equipment—provided by Prescon.

The reduced maintenance and the added design beauty of longer spans, gives increased significance to these post-tensioned, prestressed bridges.

The Prescon System of post-tensioning is being used in prestressed structures of many types because of its numerous advantages to the contractor, architect or engineer, and owner. Your copy of the new folder on lift-slabs is available now . . . write for it today.

**For the complete Prescon story, write for the new brochure.**



1. Santa Cruz River bridge, Tucson, Ariz.
2. Detail of grouted tendons in form for South Carolina bridge.
3. Stressing jack in place, and hydraulic pressure being applied. Stressing equipment and training supervision are furnished.

**THE PRESCON CORPORATION**

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*MEMBER OF THE PRESTRESSED CONCRETE INSTITUTE*

**Sidney A. Guralnick** has become an assistant professor of civil engineering at the Illinois Institute of Technology. Professor Guralnick was formerly an assistant professor at Cornell University. He has made studies of deflection, shear strength, and lateral stability of reinforced concrete beams and slabs as well as light-gage structural steel sections.

**Earnest Boyce,** chairman of the Civil Engineering Department at the University of Michigan and professor of public health engineering, has just returned from a sabbatical leave spent as a sanitary engineering consultant for the World Health Organization. From his experience in the Philippines and South Pacific Islands, Professor Boyce reports that "a primitive fear of the unknown and a belief that disease is caused by spirits and demons retard the acceptance of modern sanitation practices." In May Professor Boyce shared his findings with other public health workers at a seminar in Port Moresby, New Guinea.

S. T. Wilson

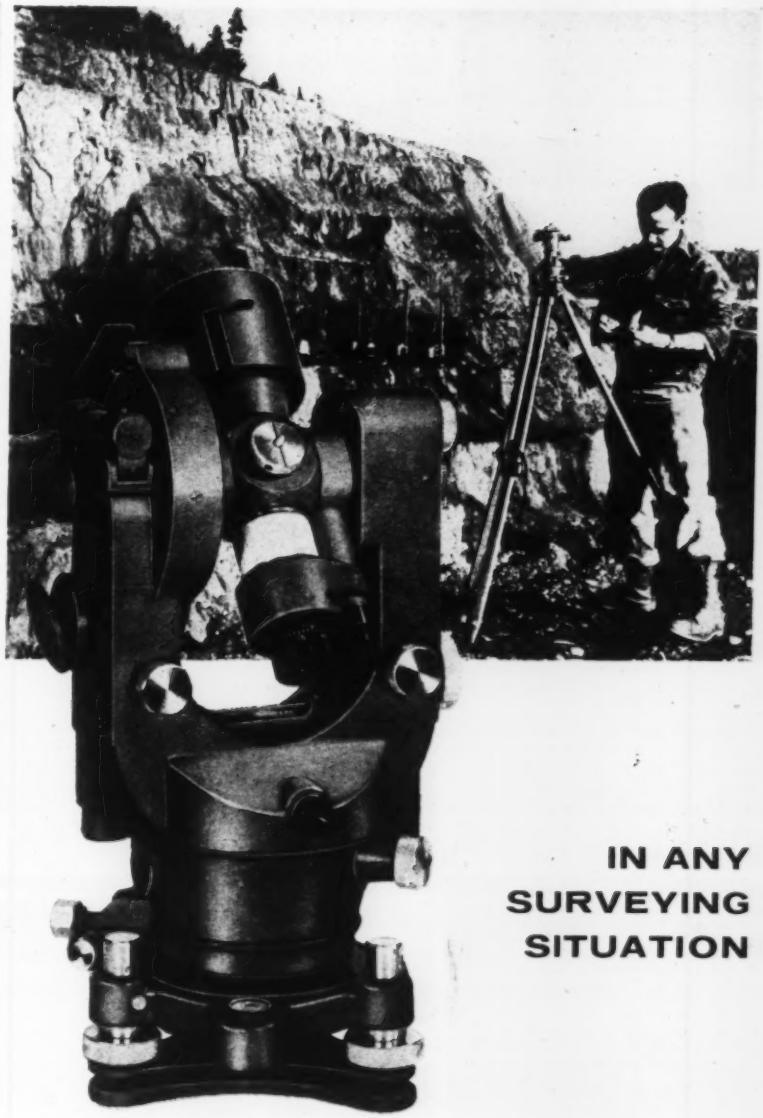
**Samuel T. Wilson** has been named head of the recently opened Harrisburg, Pa., office of the Swindell-Dressler Corporation. Mr. Wilson, a graduate of Vanderbilt University, has spent his entire career in the highway engineering field. The new office will be under the direct supervision of **Robert M. Morris,** engineer with the firm. Mr. Morris will also direct operations of the new Mexico City office.

**Dudley F. Holtman** has been named a vice president of the H. M. Byllesby and Company, Chicago investment banking and brokerage firm. Mr. Holtman has been serving as manager of the Washington office of the company, and now will head that office.

**Peter S. Marra,** who is in charge of the Mineola-Nassau office of Nussbaumer, Clarke & Velzey, has been named an associate of the firm. During Mr. Marra's eight years with the firm it has designed more than $50,000,000 worth of sanitary sewer projects for Nassau County.

**Harry G. Pazucha** has joined the sales staff of the Chicago Bridge and Iron Company in Chicago, Ill. Mr. Pazucha, who has been with the company since 1952, was formerly in the general sales department.

**Horace A. Sawyer** has been elected to the board of trustees of the Dry Dock Savings Bank in New York City. Mr. Sawyer, president of the Lone Star Cement Corporation, is also a director and member of the executive committee of Lone Star.

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Operators in mines, on highways...wherever surveying goes on...welcome the unexcelled speed and precision of the WILD T-1. You will too.

For day or underground use, the WILD T-1 combines fast set-up and error-free readings with rugged simplicity and long, trouble-free life.

Upper and lower motions for setting on zero and for repeating. Built-in optical plummet.

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**Burton H. Sexton,** former traffic and transportation consultant in Washington, D. C., announces the opening of the firm, Sexton-Setxon and Associates. The firm, which will have its offices in Bethesda, Md., and in Washington, will offer traffic consultation, noise analyses, transportation surveys, and general surveys and studies.

**Max Suter** has retired as principal engineer of the Illinois State Water Survey. Dr. Suter has been with the Survey since 1936, and has specialized in studies in artificial recharge of ground water. Since 1940 he has headed the Peoria laboratory where his research developed new theories with regard to replenishing ground water.

**Robert F. Baker,** professor of civil engineering, and **Robert Chieruzzi,** research associate, both at Ohio State University, have recently completed a report on a 15-month study of soil erosion at a Lake Erie bluff. The study was conducted at the request of the Ohio Natural Resources Department's Division of Shore Erosion.

**John Steinichen III** has been appointed planning director of the City of Birmingham, Ala. In recent Civil Service examination for the position, Mr. Steinichen placed first. He went to Birmingham from Atlanta, Ga., where he has been assistant community planner with the Metropolitan Planning Commission.

**Thomas P. Collier,** has been named director of international operations for Motorola, Inc. Mr. Collier, a specialist in overseas operations, has recently served as vice president and general manager of Bruce Payne and Associates, Inc., Chicago. The position, which is new to Motorola, has been created to coordinate the company's diverse and growing activities.

**Byron Bird** is retiring after 22 years as Washington (D. C.) District Engineer.

Byron Bird

Mr. Bird has been serving the Washington District Office since 1936, holding the positions of chief of the flood control section, chief of the engineering division, chief of the water supply division and, currently, chief engineer. Mr. Bird has spent 28 years in government service and almost 20 years in engineering teaching. He is a veteran of both World Wars.

**G. G. Greulich** has been acting as consultant to the owners of the Ceco Steel Mill at Lemont, Ill. In this capacity Mr. Greulich is working on preliminary designs, economic studies, arrangements for financing, and the supervision of the detailed engineering and construction.

**Clyde Guder** has been appointed district engineer for the American Institute of Steel Construction in the St. Louis, Mo., area. He has been active in designing and supervising construction of steel structures. In his new capacity, Mr. Guder will serve as adviser to architects, engineers and contractors in the St. Louis area.

**Morris Schupack** and **Charles C. Zollman** announce formation of the partnership of Schupack and Zollman, Consulting Engineers. The firm will specialize in precast concrete and prestressed concrete and will have offices in New York City and in Newtown Square, Pa. Mr. Schupack was formerly chief engineer and vice president of the Preload Company. Mr. Zollman, who has been a partner in Charles C. Zollman and Associates, recently represented the Prestressed Concrete Institute at regional meetings of the American Association of State Highway Officials in Minneapolis and Providence.

**Merten M. Vogel** has taken the post of chief engineer of the Frank E. Basil Company, consulting engineers in Athens, Greece. Mr. Vogel formerly served as senior civil engineer with Ammann & Whitney, and has been engaged in overseas design and construction for many years.

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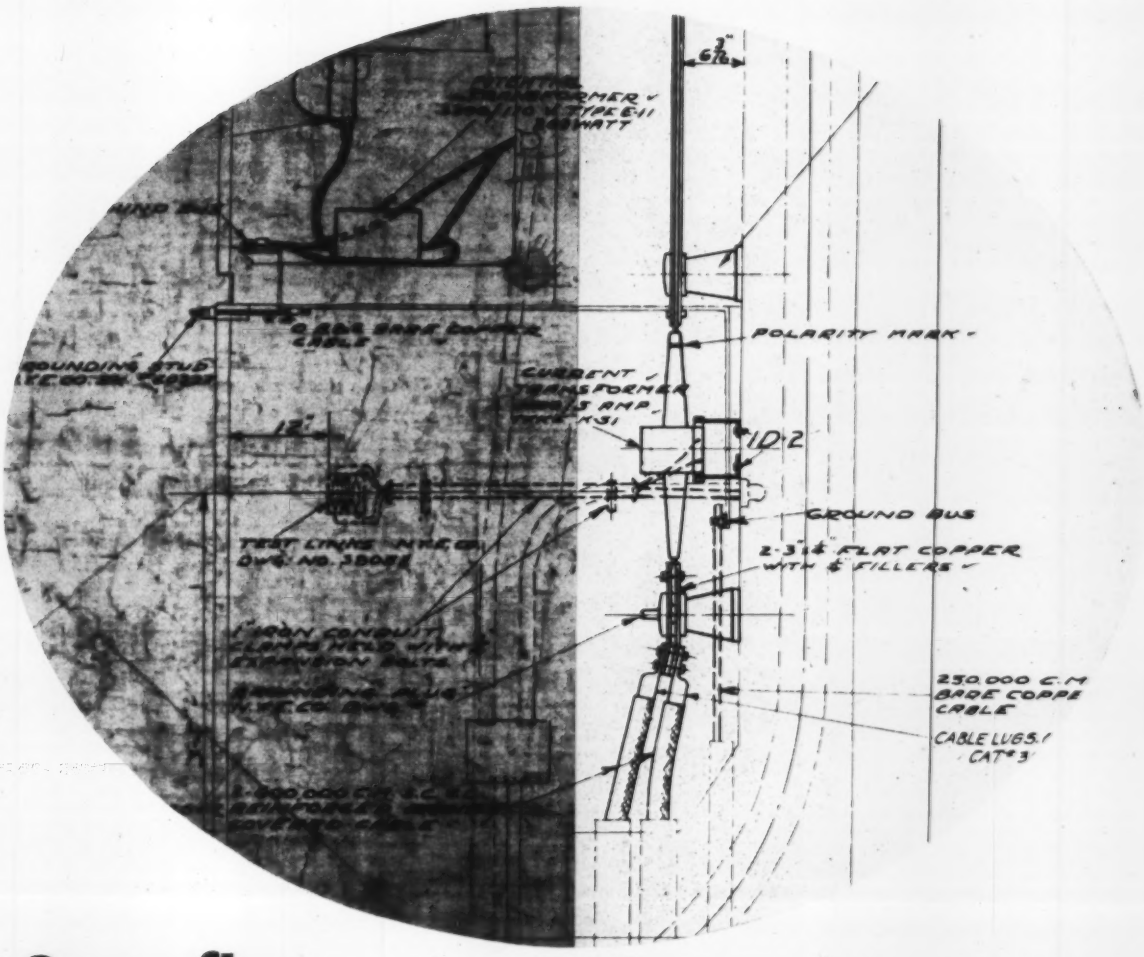
## New Publications

**Building research** . . . . The diverse needs of Canada's building industry are served by the Division of Building Research of the National Research Council of Canada. The set-up of the Division, which was formed in 1947, and its first decade of operation are detailed in a 120-page bulletin. Identified as NRC 4435, the publication may be obtained from the Division of Building Research, National Research Council of Canada, Ottawa, Canada. The price is $1.00.

**Closed conduit spillways** . . . . A series devoted to "Hydraulics of Closed Conduit Spillways" has been issued by the University of Minnesota's St. Anthony Falls Laboratory in four booklets and ten parts. The research investigations—conducted by the U. S. Department of Agriculture's Research Service and the Soil and Water Conservation Research Division in cooperation with the Laboratory and the Minnesota Agricultural Experiment Station—are reported by Fred W. Blaisdell, M.ASCE, hydraulic engineer for the Agricultural Research Service. Part I, entitled "Theory and Its Application," sells for 80 cents; Parts II through VII, "Results of Tests on Several Forms of the Spillway," are $1.50; Parts VIII and IX, "Miscellaneous Laboratory and Field Tests," are $1.50; and Part X, "The Hood Inlet," is $1.00. Orders should be sent to the St. Anthony Falls Hydraulic Laboratory, Minneapolis, Minn.

**More about nails** . . . . A new pamphlet in the VPI Wood Research Laboratory series on nailing is entitled "Nailing of Plywood Sheathing with 'Hi-Load' Nails." The publication, further identified as No. 35, may be obtained from the author, Prof. E. George Stern, Virginia Polytechnic Institute, Blacksburg, Va.

*(Continued on page 126)*

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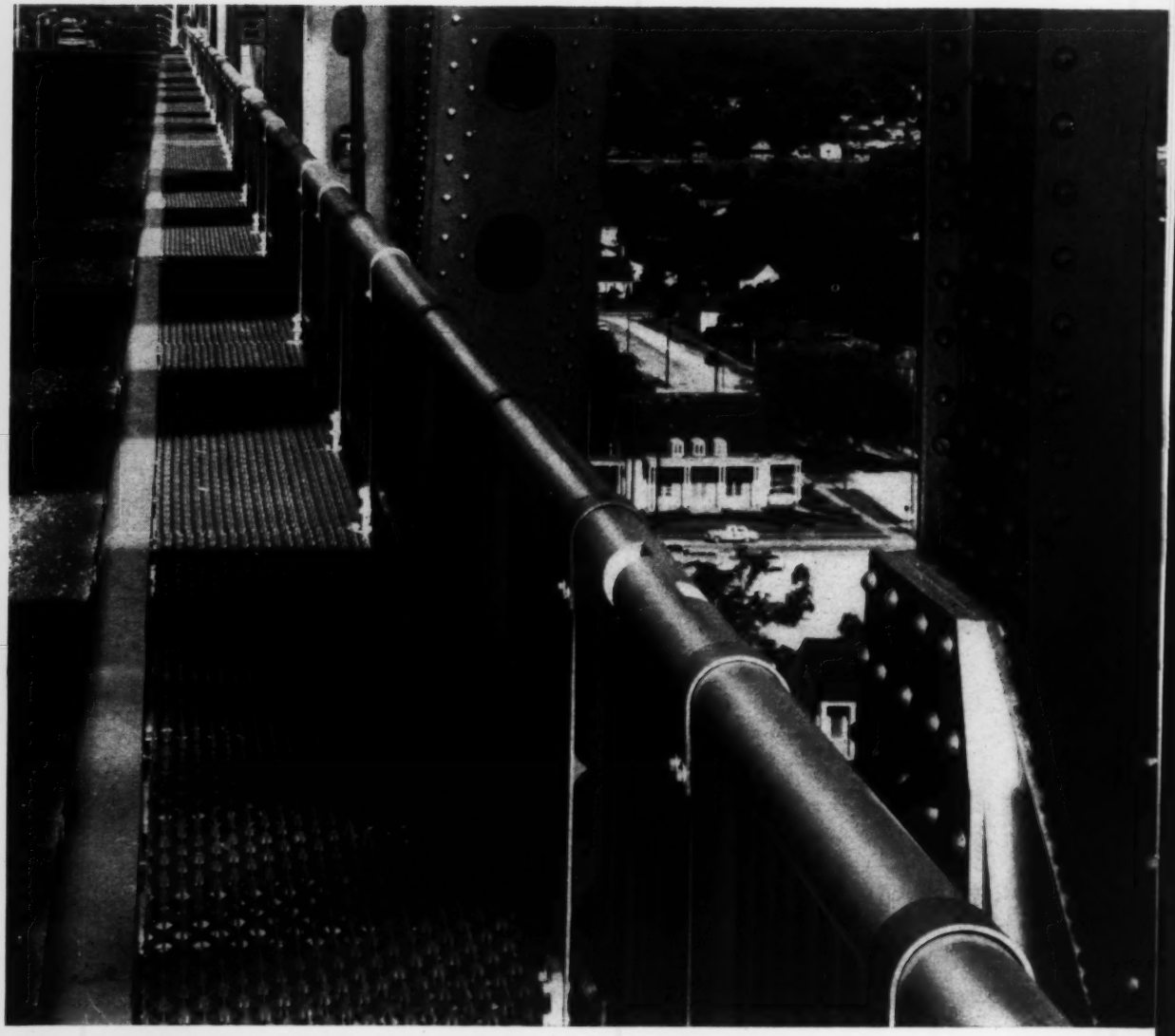

RAILINGS AND GRATING save 66 per cent of steel's weight, require less costly supporting structures and will never need painting or major repairs—because they're made of Alcoa Aluminum.

THE GREATER NEW ORLEANS BRIDGE covers 2.3 miles in approaches and main span, crossing the Mississippi River to link New Orleans proper with rapidly growing West Side communities. Fifty-two feet wide, it carries four lanes of traffic, eventually will accommodate 18,000,000 cars and trucks annually.

SPECIALLY DESIGNED LIGHTING STANDARDS of Alcoa Aluminum will withstand winds of hurricane force, never corrode or deteriorate inside or out. Six different types were designed for approaches and main span.

# 600,000 POUNDS OF ALUMINUM

## slash maintenance on world's longest cantilever highway span

Costly, never-ending maintenance and painting are outlawed on the greater New Orleans Bridge, longest cantilever highway span in the world. Over 600,000 pounds of corrosion-resistant aluminum in lighting standards, railings, grating, access ladders, chain link fencing—more than a dozen applications in all—contribute to the beauty of this structure.

Bridge components and structurals of Alcoa® Aluminum resist moisture, humidity and industrial fumes; they stay strong, attractive and easy to care for. Their lighter weight speeds construction, saves money and man power and equipment.

### MAKE TAX DOLLARS COUNT

Maintenance savings on bridge parts of Alcoa Aluminum make taxpayers' dollars go further, repay the public trust reposed in civic officials and their professional guides. Your nearest Alcoa sales office can advise you of our complete range of bridge accessories and structural parts. Or write: Aluminum Company of America, 1979-K Alcoa Building, Pittsburgh 19, Pennsylvania.

Owner: The Mississippi River Bridge Authority
Consulting Engineers: Modjeski and Masters, Harrisburg, Pennsylvania
Aluminum Fabricators:
Railings: Bethlehem Steel Company
Grating: Irving Subway Grating Company, Inc., Long Island, New York
Lighting Standards: Pfaff and Kendall, Newark, New Jersey
Access Ladders and Inspection Walks: Southwest Ornamental Iron Company, Kansas City, Mo.
Overhead Sign Structures and Signs: Pfaff and Kendall, Newark, New Jersey

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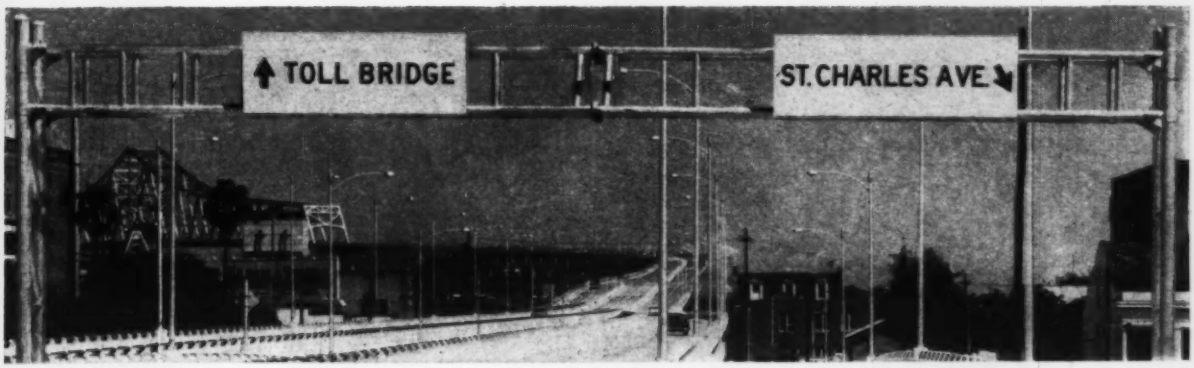
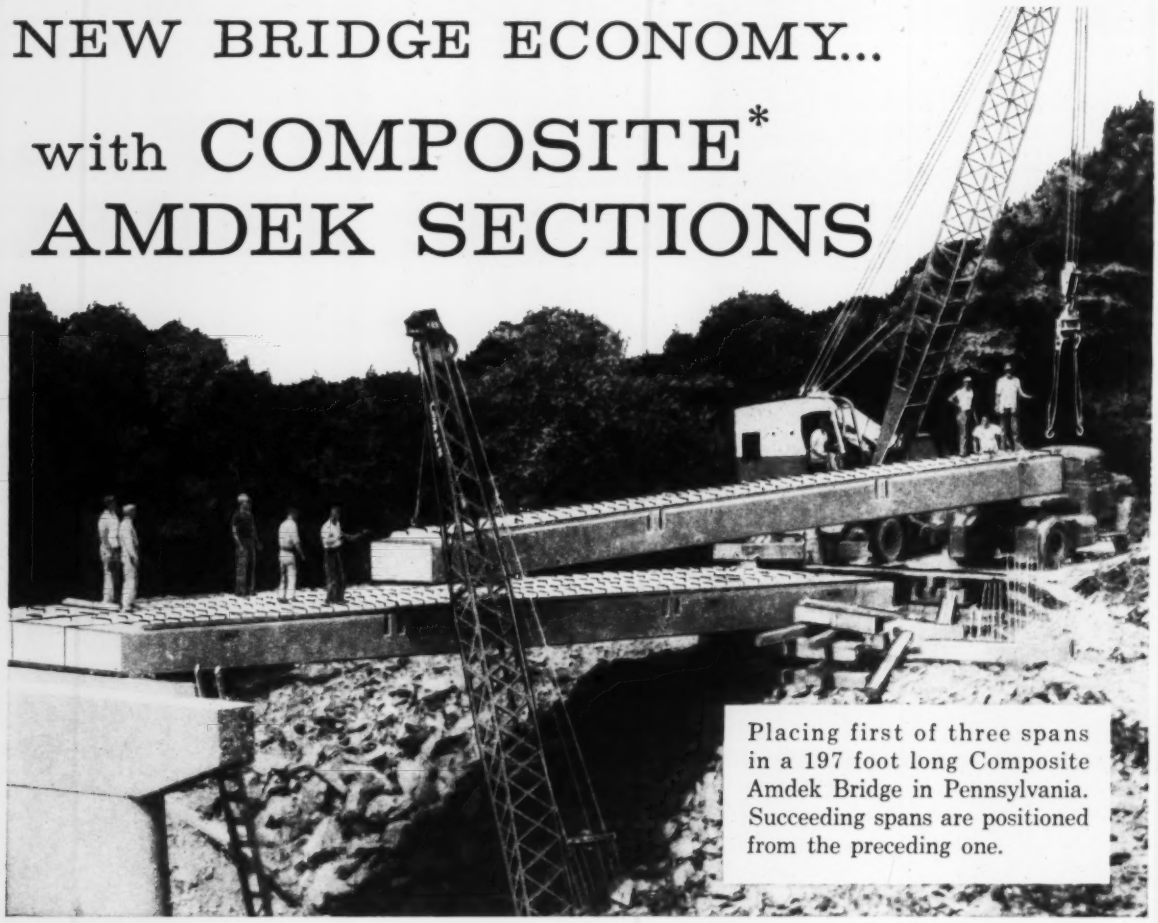



OVERHEAD SIGN STRUCTURES AND SIGNS of aluminum completely eliminate painting and maintenance problems that tie up traffic and create safety hazards. Light in weight and easy to install, they stand up to winds of 100 mph.

# NEW BRIDGE ECONOMY...

## with COMPOSITE* AMDEK SECTIONS



Placing first of three spans in a 197 foot long Composite Amdek Bridge in Pennsylvania. Succeeding spans are positioned from the preceding one.

## Another example of American-Marietta PROGRESS in CONCRETE

*After the new four-foot wide Composite Amdek Sections are positioned, a four-inch concrete deck is cast over the raised stirrups. The box sections and surfacing then become an integral working unit.

Composite Amdek Sections with concrete surfacing require less concrete, less handling and no form work—which results in considerable savings. Independent dynamic tests have proven their tremendous fatigue strength.

For information on this and on standard three-foot wide Amdek Beams without raised stirrups for use under asphalt surfacing, contact American-Marietta Company.

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**CONCRETE PRODUCTS DIVISION**
GENERAL OFFICES:
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101 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS, PHONE: WHITEHALL 4-5600

# . . . . . *Am-Soc Briefs*

▶ ▶ Last-minute thoughts on the Convention. . . . For those who overlooked the Annual Convention program in the September issue, this is final reminder that the week-long program will have something for every civil engineer and his family. . . . The backdrop for the big meeting will be another spectacular Civil Engineering Show -- an enlarged version of the manufacturers' display that proved so successful at last year's Convention. . . . An important piece of business slated for discussion at the Annual Business Meeting on October 15 is the proposed amendment for reclassification of members. At this session every member will have a chance to question and discuss and even amend the proposal before the amendment goes to ballot (a detailed explanation of the proposed changes has been sent to each member). . . . At the Convention, also, new members of the Board of Direction will take office, new Honorary Members will receive their citations, and new ASCE prize winners their awards. The brief biographies leading off Society News will help you get acquainted with these distinguished folk.

▶ ▶ Member gifts for the UEC. . . . For the first time "Civil Engineering" carries (in Society News) a tabulation of gifts for the United Engineering Center by Zones, Districts, and Local Sections. It will be noted that Zone I and District 4 are ahead with their quotas. Local Section honors go to the Kentucky Section, which has currently filled 73 percent of its quota.

▶ ▶ New ASCE publications. . . . Manual 29 -- on the Private Practice of Civil Engineering for Engineers and Clients -- is ready for publication as soon as the Board gives its final nod to the project this October. The new edition, the first since 1952, has raised fee curves to embrace projects up to $100 million. It also includes a valuable special section on fees for highway work prepared at the request of Federal Highway Administrator Tallamy. . . . To make the work of our 140 hard-working Faculty Advisers easier, the Committee on Student Chapters has just issued a Faculty Advisers Guide. Two years in preparation, the Guide supplements the standard Student Chapter Handbook. . . . Finally, two new additions to the Proceedings Symposium series are now available. The volumes -- entitled McNary Dam Symposium and Symposium on Rockfill Dams -- may be ordered by use of the coupons in the advertising section.

▶ ▶ Don't let your membership lapse. . . . Notices have gone to 1,000 Junior Members, reminding them that by December 1 they will have reached the age limit for their grade and must transfer to Associate Member. If you are one of these, you will want to take action at once to retain your membership in the Society.

▶ ▶ Our far-flung front. . . . Society interests and activities are too numerous and diverse for coverage in any one publication. In September -- to mention a representative group of activities -- the Research Committee joined the National Science Foundation and George Washington University in sponsoring an important full-scale Conference on Basic Research in Civil Engineering; the Irrigation and Drainage Division and the Mid-South Section sponsored a four-day conference in Memphis, Tenn., on Water Use in Humid Areas; and a new Construction Division Committee on Contract Documents met in Kansas City. Incidentally, the Construction Division has recently been reorganized to include twelve important new committees.

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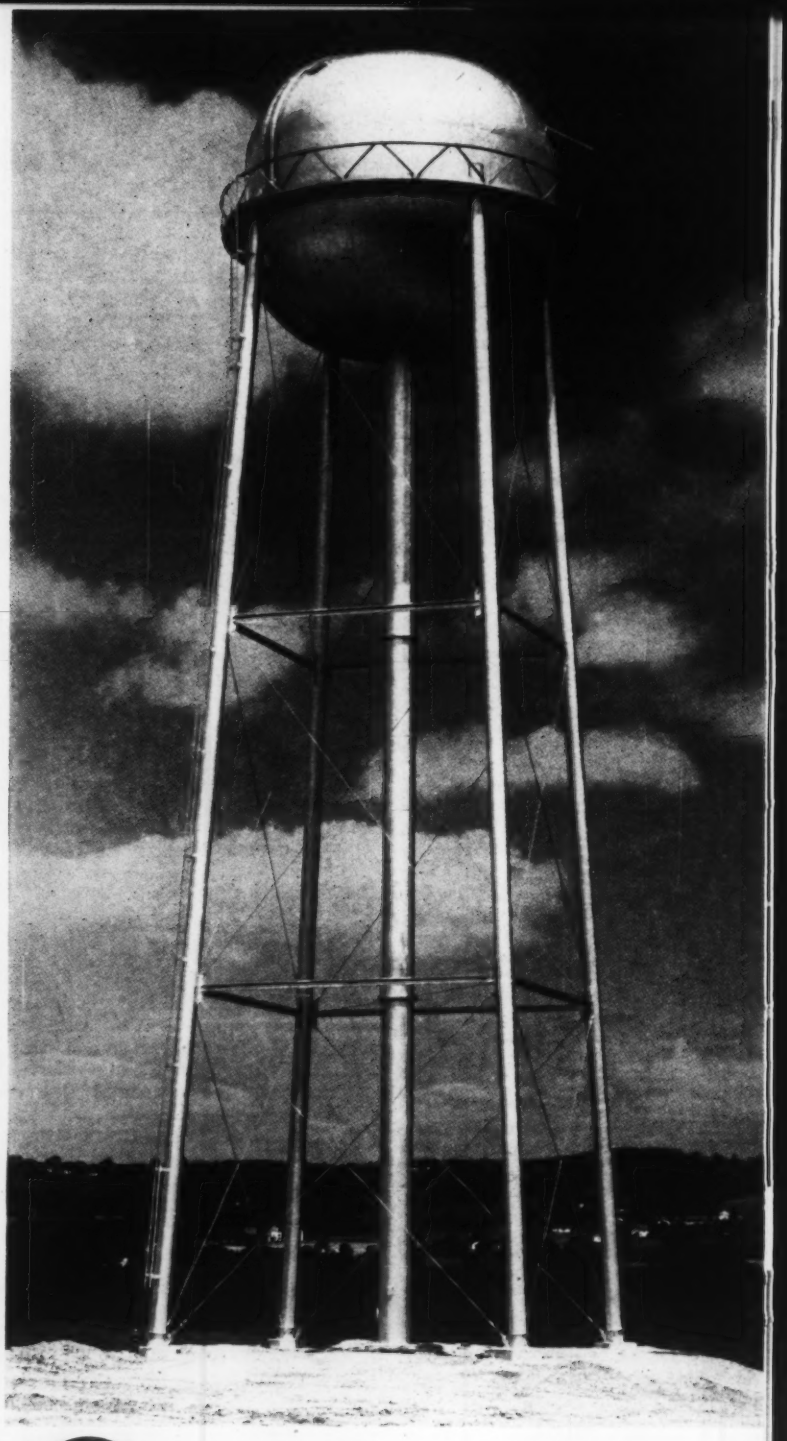

An ever-dependable water supply, as sure as the law of gravity—on your own property for your own plant service and protection! That's the net of modern water storage in Pittsburgh-Des Moines Elevated Steel Tanks. There's a type and size to match your process and fire protection requirements, at low cost and guaranteed satisfaction. Write for our comprehensive water storage brochure!

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# do you know that

**The construction dollar is the most rewarding spent in a community?** For each $1 billion put into construction, 5,715,000 work-weeks (of forty hours) are provided in on-site and direct off-site employment. Put another way, each $1 billion invested means 228,600,000 man-hours of work. These facts were brought out in recent testimony of the American Road Builders Association before Congress when legislation to amend the Federal Airport Act was under study.

• • •

**Steam geysers will be used for electric power in California?** In the first experiment of its kind in the United States, engineers of the Pacific Gas & Electric Company are attempting to trap the natural steam from geysers in Sonoma County, north of San Francisco, and will install a 12,500-kw generating plant. The initial cost of production and transmission is estimated at $2,000,000. Geothermal plants have been in successful operation in Italy for over thirty years, and similar units are being developed in Mexico and New Zealand.

• • •

**Allowable unit stresses for open-web joists will be raised from 18,000 to 20,000 psi?** In anticipation of the change-over on January 1, the Steel Joist Institute has made ready new load tables based on the higher stresses. Copies are available from the Institute, DuPont Circle Building, Washington, D.C.

• • •

**The job outlook for young engineers is still good?** An EJC placement survey of 1958 engineering graduates reveals that 83.5 percent of an estimated 33,000 graduates were hired a month before graduation. By May only 10 percent were without firm job offers. Conditions for business administration and liberal arts graduates were much less favorable. The survey was based on information supplied by engineering deans in over 100 colleges. The full report is available from Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

• • •

**France leads Europe in good roads?** Its tradition of fine highways goes back to the early seventeenth century when Minister de Sully, adviser to Henry IV, started a national system of roads surfaced with crushed stone. In addition to having the finest system of paved highways on the Continent, France also has the densest highway network in the world—1,500 ft of roadway for each square mile. Its mileage of roads and through streets totals 717,600.

**Evaporation takes enough water from our Western lakes and streams to fill several major storage reservoirs a year?** A recent Geological Survey report indicates that more than 11,500,000 acre-ft are lost to the atmosphere annually in eleven Western states. According to Secretary of the Interior Fred Seaton, this equals the combined capacity of the storage reservoirs at Shasta, Hungry Horse, Seminoe, and Elephant Butte dams. Bureau of Reclamation efforts to combat the serious loss include testing the feasibility of protecting water surfaces with a thin hexadecanol coating.

• • •

**Lack of uniform codes is seriously impairing our building efficiency?** This is the substance of a talk delivered by William B. Tabler at a recent meeting of the American Institute of Architects. As a case in point, he cited New York City noting that, under existing codes and zoning laws, it is impossible to build a profitable convention hotel, and that not one has gone up in the past twenty-six years. "If you build a hotel there instead of an office building, you have to throw away approximately 35 percent of your land," he asserted.

• • •

**Dutch engineers will advise us about draining the Jersey Meadows?** Reclamation engineers from Holland are touring the Hackensack (N. J.) marshes, by plane, car, and boat, to determine the feasibility of draining the area. These experts, representing Netherlands Engineering Consultants, have three possibilities in mind: (1) sealing off the Hackensack River by building a dike across the marshes; (2) building dikes along the river banks and Newark Bay, which will leave the stream open to tidal action; and (3) dividing the meadows into segments and diking them according to land use.

• • •

**Alaska is for civil engineers?** Our newest and largest state has only 5,000 miles of roads in its entire 586,400-sq mile area. Only 5 percent of its vast area has been surveyed. There are twelve known large dam sites and 91 major potential power sites. Alaska's largest single industry is construction, ranking twenty-third among the states in construction dollar volume (in 1954 is would have been the fourth state in dollar volume). These are a few of many interesting engineering facts about the country assembled in the August issue of the *Pacific Builder & Engineer*.

# Gateway TO THE STARS

***Dramatic Concrete Ramp at New York International Airport Provides Graceful Access to Arrival Building***

• "Gateway to the Stars"—at Idlewild Airport—is a curving reinforced concrete promenade which connects with a prestressed concrete bridge leading to the Arrival Building.

Imaginative and daring in design, this strikingly modern ramp, set on widely spaced concrete columns, skirts the edge of the broad circular reflection pool in a graceful sweep.

The bridge which leads through the 11-story control tower, is fabricated of prestressed concrete channel beams made with 'Incor'*, America's FIRST high early strength portland cement, and also utilizes widely spaced columns.

Well-integrated designs, coupled with concreting know-how, make this a quality job of highest order. Artistry in concrete has been achieved, plus an all-important economy that lasts for the life of the structure, making the most of today's construction dollars.

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Owner: **PORT OF NEW YORK AUTHORITY**

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**SKIDMORE, OWINGS & MERRILL** (Building and Bridge)
Associate: **WALLACE K. HARRISON**
**HERBERT FLEISCHER** (Pool and Ramp)
All of New York City, N. Y.

Contractor: **TULLY & DI NAPOLI, INC.** (Bridge, Ramp, Pool)
Flushing, New York

Prestressed Bridge Beams
**PRECRETE, INC.** Flushing, New York
Soil Cement: **FRANK MAMORALE, INC.**
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Masonry:
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# One world of civil engineering

The technical and professional problems of civil engineering are much the same the world over. When the experts from many nations join together for the frank exchange of information, each nation benefits from the exchange, and the professional men develop confidence and respect for one another. Engineers of America are to reap the benefits flowing from the meetings of several great international engineering organizations held in North America and Europe this year.

What are the recent advances in structural engineering design and construction in this country and abroad? ASCE is providing answers to this question at its Annual Convention in New York this month. Current developments in the world are to be reviewed during the eight joint half-day sessions of ASCE and the International Association of Bridge and Structural Engineers. A score of leading engineers from eight European countries and the United States are scheduled to participate.

The program will cover a wide range of subjects intended to present the latest developments in both research and practice for economical construction of utilitarian yet beautiful structures in steel and concrete. In steel the plastic method of design, and the effects of ductility, fatigue, and creep will be discussed; in concrete, the ultimate strength and limit design, precast and prestressed members, thin shells and folded plates. One article, based on the Convention paper by Prof. T. Y. Lin, is in this issue. It reports research and advances in lift-slab techniques and thin-shell design.

What are the "Economic Trends in the Production, Transportation, and Utilization of Fuel and Energy"? In Montreal, September 8-11, the Canadian National Committee was host to the World Power Conference, where answers to this question were offered by experts from Europe, Asia, Australia, and the Americas.

In New York, September 15-30, the Sixth International Congress on Large Dams held its sessions, at which 760 professional men from many nations compared experiences. More than 160 papers originating in 40 nations were presented on four phases of dam construction—raising the height of dams; comparing actual stresses and deformation with theoretical calculations; compaction methods for earth and rock-fill dams; and use of admixtures in dam concrete.

In Montreal, September 3-6, the Fifth Convention of the Pan American Federation of Engineering Societies (UPADI) was held with representation from engineering societies in 14 countries of the Americas. There discussions relating to the education of engineers took the spotlight.

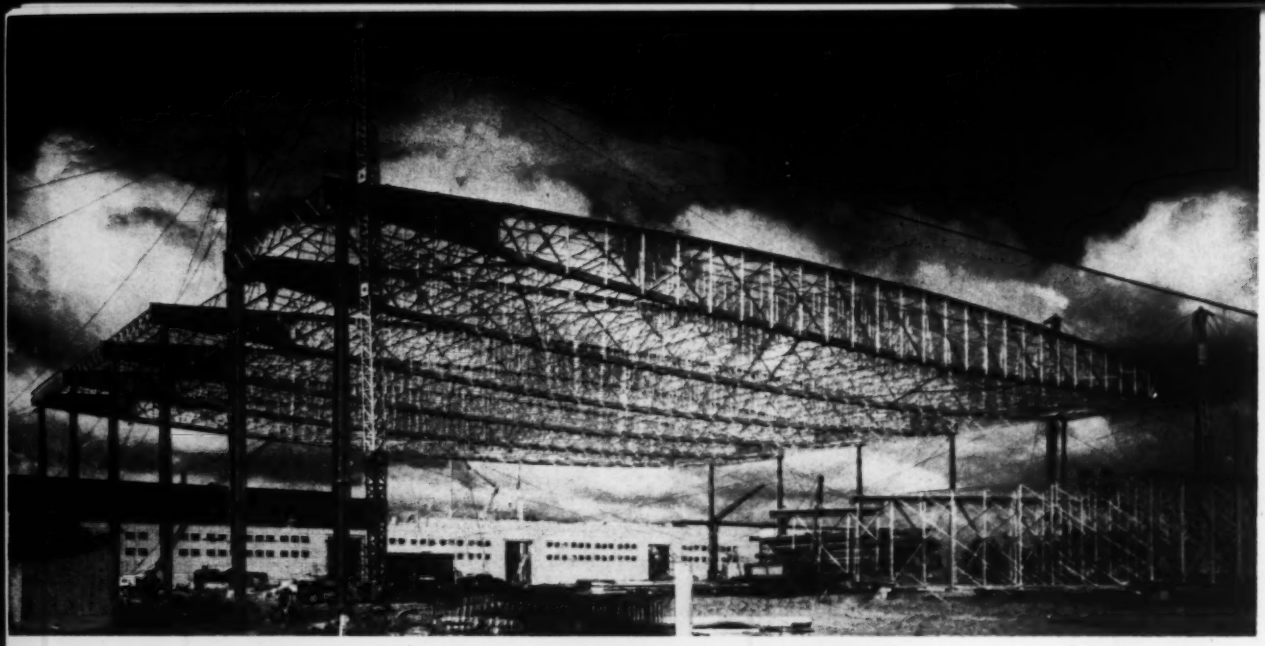
In Berlin the International Federation of Prestressing held its Third Congress May 5-10. Delegates from 44 countries contributed to the exchange of information in the rapidly developing field of prestressed concrete. An informative report on advances in European precasting and prestressing practices as presented at this congress was published in the September issue of CIVIL ENGINEERING, pp. 102-106. A year ago the IFP Congress met in San Francisco.

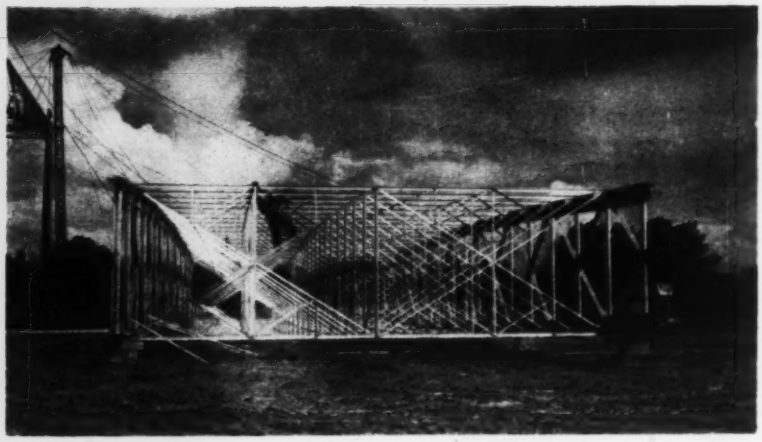
Mexico City is to be host to the International Road Federation, where the Third World Meeting is to be held October 26-31.

In this issue are presented several outstanding structures designed and built by Belgian, French, Russian and American civil engineers. Among them is the Transportation Pavilion at the World's Fair in Belgium, where aluminum proved to be the economical material for the roof trusses. Another article describes an all-welded aluminum highway bridge just constructed by the Iowa Highway Commission. In Spain, American and Spanish experts designed and built the Port of Rota to supply the U.S. Air Force Bases. In Sweden the 1½-mg prestressed concrete water tank shown on the cover of this issue was erected by the ingenious method of precasting the bowl at ground level and jacking it up to final position in successive 4-in. stages as the hollow concrete stem was cast. On the Ivory Coast of French West Africa, at Abidjan, a beautiful prestressed concrete bridge, notable for its box-girder spans large enough to carry trains inside of them and vehicles on top, has been completed almost wholly with native labor, from the plans of French engineers.

An unusual opportunity to look at Russian precast prestressed concrete construction was offered to half a dozen U.S. engineers who attended the IFP Congress in Berlin. An illustrated article by one of them, also in this issue, describes the aggressive steps being taken by engineers in the USSR to design, manufacture, and erect precast-concrete elements for buildings and bridges. Mass production is the word there.

These exchanges of knowledge and experience between the civil engineers of many nations surely are valuable to the professional men of each country, and more important, they contribute to international understanding.





Section of roof deck has been assembled on grade, with purlins for one span, between two main trusses.

*Selected from among 57 projects originating in 15 countries, including the United States, the Transportation Pavilion at the Brussels World's Fair was chosen for the R. S. Reynolds Memorial Award 1958, which was presented at the Cleveland Convention of AIA in July. The award was made to a team of six architects and the consulting engineer, Mr. Lipski, all of Belgium, for a structure considered to be esthetically and structurally the most significant in the use of aluminum. A member of the jury, Pier Luigi, praised the originality of the solution which utilizes ties in permanent tension connecting columns and trusses. He stated: "This structure again emphasizes the indissoluble tie which unites architectural aspect and structural substance."*

*Charles C. Zollman, M.ASCE, translated Mr. Lipski's French manuscript, and also prepared the appendix, in which Mr. Lipski's economic comparisons between steel and aluminum structures are applied to conditions in the United States.*

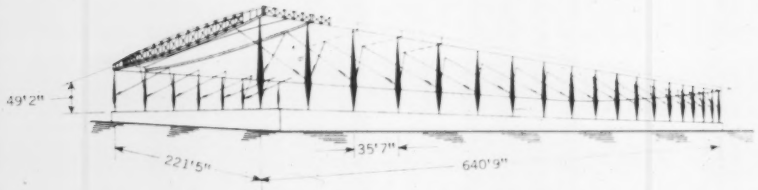
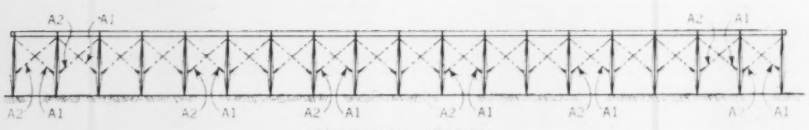
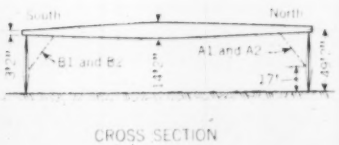



FIG. 1. Isometric indicates general design features of Transportation Pavilion, Brussels Exposition.

FIG. 3. Each column consists of steel pipe of 11-in. diameter to which three fins are welded at 120-deg angles. Fins consist of T-sections cut from 10-in. I-beams.

FIG 2. Longitudinal and Transverse sections of Transportation Pavilion show 19 main roof trusses, all of aluminum, supported by 38 steel-pipe columns.



Cranes erect Pavilion roof frame, seen from southwest corner.

## *Transportation Pavilion at Brussels World's Fair*

# ALUMINUM ROOF PROVES ECONOMICAL

**A. LIPSKI,** Consulting Engineer, Brussels, Belgium

The Transportation Pavilion at the 1958 Brussels World's Fair is an open building without structural end or side walls, expressing thus, through the continuity of exterior and interior space, the theme of transportation by land, sea, and air.

The immense roof framing and deck, with its profile of two parabolas of opposite concavity cover, without intermediate supports, an area of 642 by 226 ft—about 146,000 sq ft. Framing and deck are almost entirely of aluminum.

Thirty-eight columns 47½ ft high, each hinged at the top as well as at the bottom, in two lines of 19 columns each, 221 ft on centers, support the 19 main aluminum roof trusses, spaced 35 ft on centers (Figs. 1, 2, and 3). Trussed aluminum purlins 6 ft 6 in. on centers connect these parabolic main trusses. The depth of each purlin corresponds to that of the main truss at the junction of the two. The roof framing thus achieved by main trusses and trussed purlins is wind braced in both vertical and horizontal planes. A 21-gage corrugated aluminum skin covers the trusses. Lap joints and plastic material insure the required waterproofing. Corrugated aluminum sheets of 28 gage, in the plane of the bottom chords of the trusses, make up the lower skin of the deck. The entire aluminum roof framing and deck is thus an extremely light structure.

Such a structural frame—a roof deck on two lines of hinged columns at top and bottom—is a completely unstable structure. The slightest wind pressure would cause it to collapse just as an articulated parallelogram would. A special tie arrangement, shown in Figs. 1 and 2, provides the necessary stability for the entire structure.

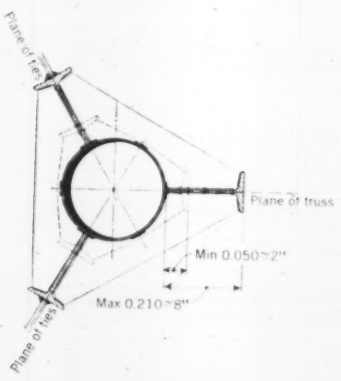
At about 17 ft above grade, one tie connects each column to the main truss that rests on the preceding column, and a second tie connects the same column to the truss that rests on the succeeding column. In this fashion, windbracing in both the longitudinal and the transverse directions is obtained. Four groups of ties—$A_1$, $A_2$, $B_1$ and $B_2$—corresponding to four different directions, are provided. Thus, with a wind pressure from any direction, two of the four groups of ties, assumed for the time being to be simply connected to the structural members, will prevent failure of the roof deck, whereas the two other ties will be relaxed.

This arrangement of ties—without pretensioning—meets the requirements of statics ($EV = 0$, $EH = 0$, and $EM = 0$) and prevents failure of the structure, whatever the loading. However, further study of the problem reveals that it is not sufficient simply to provide these ties to meet the requirements of statics; they must be pretensioned when installed. Furthermore, springs along the axis of each tie must be installed so that the pretensioning will produce a sufficiently large elastic elongation.

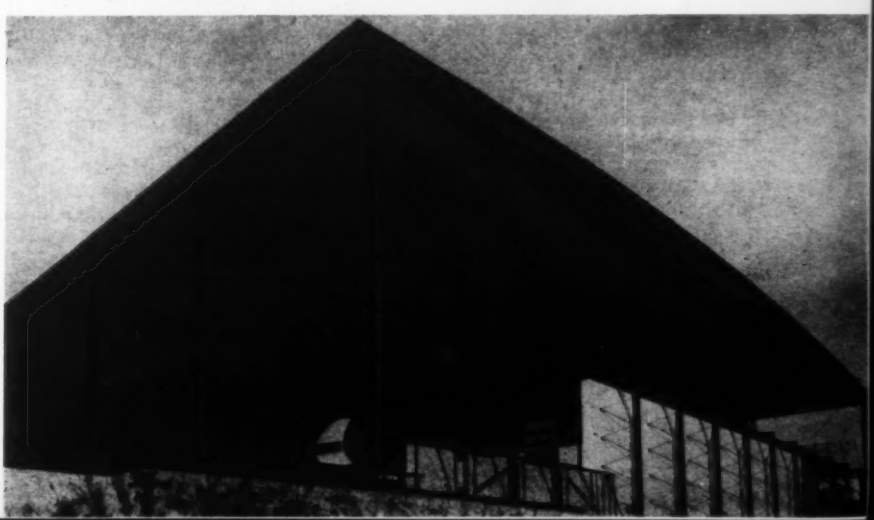
Since each wind direction induces stresses in two groups of ties, while the other two groups are relaxed, the following conditions will result, making pretensioning necessary:

1. A change in wind direction, after roof-deck movement has occurred, will cause the relaxed ties to straighten and to be suddenly stressed. This sudden reversal from no stress to a stressed condition is dangerous and unacceptable.

2. If the ties are not pretensioned, snow loads will cause all the ties to be




**Completed Pavillion is seen from southeast corner.**



in a relaxed condition. Not only will sagging ties look badly, but wind action from any direction added to the snow load will again cause a sudden introduction of stress in some ties, resulting in the unacceptable situation mentioned above.

3. An increase in temperature results in similar unacceptable sudden stresses.

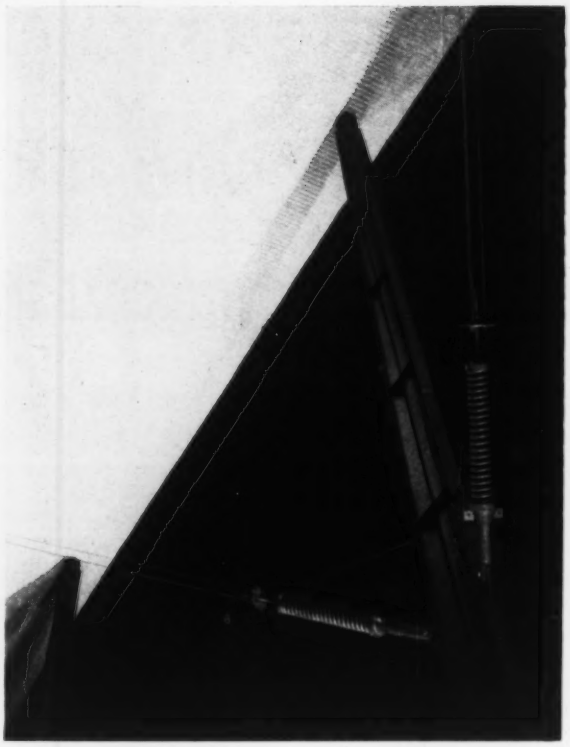
Pretensioning of all the ties corrects this situation as each tie becomes a member not only capable of sustaining tensile stresses in addition to those induced by the pretensioning, but also capable of sustaining compressive stresses, conceived of as stresses to be subtracted from the induced pretensioning tensile stresses. That is, the magnitude of the pretensioned tensile stresses is reduced. Of course, the induced pretensioned tensile stress must be sufficiently great so that the member remains at all times in tension regardless of load. As a result, all four ties, instead of two out of each group of four, take part in the equilibrium system, whatever the loading.

Such pretensioning in itself, however, will not be effective unless it produces in each tie a corresponding, and sufficiently large, elastic elongation. Ties made up of three smooth high-tensile-strength steel wires of 0.276-in. diameter, such as are commonly used in prestressed concrete construction, capable of high tensile stresses and correspondingly high elongation, proved to be insufficient because of the high elastic and thermal deformations of the all-aluminum roof deck.

If springs are not provided, pretensioning alone will cause the ties to elongate only 1½ to 2 in. But snow loads will cause the roof trusses to deflect 6 in. at the connecting points of the ties. Thus the forces introduced in the ties by pretensioning are nullified by a load equal to less than a third of the design snow load, and the undesirable condition of relaxed ties will prevail. By providing springs in each tie, their large elastic deformations, added to the elastic deformations of the three pretensioned wires, will prevent the induced tensile stresses from being nullified by any load that may be applied, or by any change in temperature.

The flexibility provided by the springs appreciably reduces the maximum stresses due to temperature variations. Temperature stresses are internal "parasite" stresses which should be reduced as much as possible.

Further, without springs it would have been impossible to provide a roof deck without expansion joints because aluminum is a material extremely sensitive to thermal variations. Particularly in this structure, because of aluminum's high expansion coefficient and the unusual thinness of the members, cooling or heating due to variations in air temperature is rapid and pronounced.



**Close-up shows part of a column and ties, with springs.**

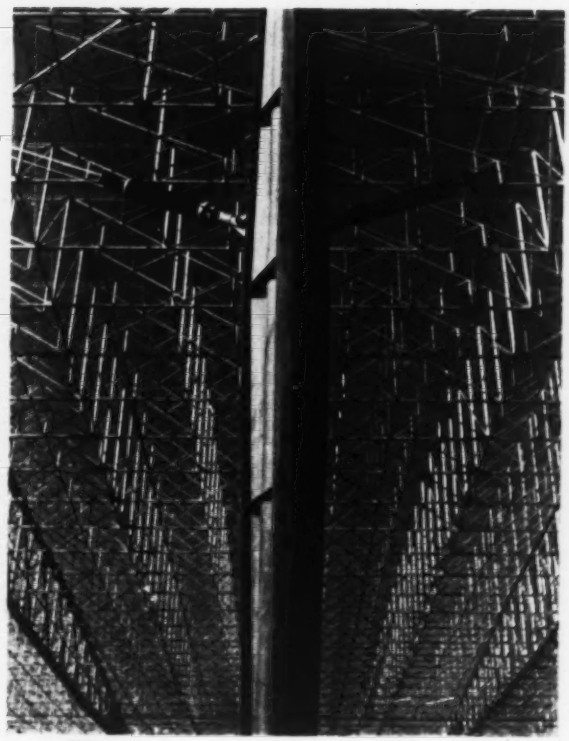
It might appear that the tensile stresses in the ties due to wind pressure would substantially increase the tensile stresses already provided by pretensioning. However this is not the case because the four groups of ties are working simultaneously. Each group carries only half the stress it would carry were it not prestressed. That portion of the prestress required to resist the wind pressure is equal, in principle, to the other part, and their summation does not change.

The provision of springs has advantages but it also brings up fundamental problems requiring careful consideration—in particular the great mobility of the entire structure due to horizontal wind pressures.

A horizontal displacement at the top of a column of the order of 12 in. results from full horizontal design wind loads. Fortunately the absence of walls, or at least of walls connected to the roof deck or to its supporting members, makes this mobility acceptable by itself. However, such mobility brings up two extremely delicate problems in the dynamic equilibrium of the entire framing:

**1. Resonance frequency.** Most structures have an oscillation period of less than one second, and the danger of resonance with repeated wind action can be considered as non-existent. The exceptionally large deformations of the Transportation Pavilion required an investigation of this problem, as it was not immediately evident whether there would be danger from resonance in this case. Computations of the vibration period of the framing system, roof-columns, ties and springs indicated a period of 4.27 sec. Evidently the resonance of this structure differs widely from that of the usual structure. A study of the theoretical and factual data in a report by Messrs. L. Baes and A. Joukoff, on wind velocity in Belgium, from the point of view of structural calculations, published in September 1948, led to the conclusion that the frequency of the Pavilion is acceptable.

**2. Aerodynamic stability of framing system.** The second delicate problem posed by the mobility of the framing system is its aerodynamic stability. The question arose as to whether there was danger of failure from the same cause that led to the destruction of the Tacoma Narrows Bridge. It will be remembered that failure in that case was due to a persistent wind of rather low intensity acting on a structure which was aerodynamically unstable. An initial deformation of the structure aggravated the effect of the wind, which in



**In view of a column, with springs, aluminum roof framing stands out against the sky. Photo Coulommier, Brussels.**

turn aggravated the initial deformation. The effects, being cumulative, eventually reached enormous proportions and with them oscillations of very large amplitude.

The answer to this troublesome question was reassuring. The effect of the wind on the Transportation Pavilion does not change with the deformations it causes, since the roof deck remains parallel to itself.

### Structural details

Steel-pipe columns support the roof deck. These columns, shown in Fig. 3, have a diameter of 11 in. and a wall thickness of ¼ in. To each column three structural steel T-sections, cut from 10-in. I-beams, are welded at 120-deg angles. This rational arrangement gives to the column a slim profile "of equal resistance," similar to the roof trusses, and also provides for the bending moments in the columns induced by the reactions of the ties.

The cut of the structural T's is such that no material is wasted. It should be noted that in cross-section (Fig. 3) the webs of two of the column wings are in the same vertical plane as the ties, whereas the web of the third wing is in the same vertical plane as the trusses. The pipe columns serve also for roof drainage.

The column hinges are designed so that they can function both in compression and in tension—in compression for dead weight of roof deck and snow load, and in tension should upward wind pressure cause uplift on the roof deck.

Of special design, the hinge arrangement permits free movement in all directions. Uplift forces are quite important because of the extreme lightness of the roof deck and because wind will be deflected from below. This problem was the subject of an experimental investigation at the Aerodynamic Center of Rhode St. Genese near Brussels. As a result, the depth of foundations had to be increased to 6½ ft, even though soil conditions did not require it, so as to prevent the foundations from being lifted out under certain conditions of wind intensity and direction.

The coil-type springs on the columns are mounted on telescoping attachments designed so that, as the attachments elongate, the springs are compressed. The ties were tensioned by tightening two screws on two long threaded rods mounted temporarily on each attachment. A prestress of 4,200 lb was applied to the ties in this manner. Under varying design loads, this force will vary between 700 and 10,700 lb, with a corresponding variation in the length of the tie up to 12 in.

The section of the ties connecting the spring attachments to the roof truss is made up of three wires of 0.276-in. diameter of the type used in prestressed concrete work. In section these three wires form an equilateral triangle.

### Why an aluminum roof?

Aluminum for structural members is still in limited use because its cost per unit weight is still high. Only when the dead load of the framing, based on the use of structural steel, appears to be substantially larger than all the superimposed design live loads, can the use of aluminum be economically justified.

The following elementary reasoning substantiates this statement. The cost $C_s$ (in francs) of a structural steel bar of length $L$ (cm) to resist the total tensile force $F$ (kg) can be expressed by

$$C_s = L \frac{F}{f_s} \delta_s U_s$$

where:

$f_s$ = allowable steel tensile stress, kg per cm²
$\delta_s$ = specific weight of steel, kg per cm³
$U_s$ = unit cost of steel framing erected, francs per kg

Similarly the cost, $C_a$, for an aluminum bar would be

$$C_a = L \frac{F}{f_a} \delta_a U_a$$

as it is sufficient to change the subscript $s$ for steel into the subscript $a$ for aluminum. This being established, the cost of a steel bar can be compared with the cost of an aluminum bar of the same length to resist the same total force, $F$,

$$\alpha = \frac{C_s}{C_a} = \frac{f_a}{f_s} \times \frac{\delta_s}{\delta_a} \times \frac{U_s}{U_a} = \frac{\rho}{\beta\gamma} \quad . \quad . \quad (1)$$

If $\rho = f_a/f_s$ and $\beta = \delta_a/\delta_s$ then, for the Transportation Pavilion, $\rho = \frac{1230}{1400} = 0.88$, and $\beta = \frac{2{,}700}{7{,}850} = 0.344$.

$f_a = 1.230$ kg per cm² = 17,600 psi, which is the average of $f_a$ for tension and $f_a$ for compression.

$\gamma = \frac{U_a}{U_s}$ is a variable depending on such factors as economic conditions, country, and type of structure.

Using the average Belgian values,

$$\gamma = \frac{80 \text{ francs per kilogram}}{16 \text{ francs per kilogram}} = 5$$

and substituting in Eq. 1,

$$\alpha = \frac{\rho}{\beta\gamma} = \frac{0.88}{0.344 \times 5} = 0.511$$

This means that to resist the same total force, the cost of the structural steel bar will be only 51.1 percent of that of the aluminum bar.

Generally, however, the use of alumi-

num calls for less total resisting forces. However, such a decrease in required total resisting force must be substantial if the spread between the two costs is to be reduced appreciably. This can only be accomplished if the dead weight of the structural steel framing is much greater than the total superimposed design loads. Breaking down the total design load into two parts:

$W_{DL}$ = dead weight of structural steel framing
$W_{TL}$ = total superimposed load

Then $W = W_{DL} + W_{TL}$.

With the substitution of aluminum for steel, $W_{DL}$ obviously decreases while $W_{TL}$ remains unchanged. The following can then be written:

Total load with use of aluminum = $W' = W_{Al} + W_{TL}$, if $W_{Al}$ is the dead weight of the aluminum framing. For the cost of the aluminum framing to be exactly equal to that of the structural steel framing, $W'$ must equal $W$. Hence, the decrease in total load is equal to

$$r = \frac{W'}{W} = \frac{W_{Al} + W_{TL}}{W_{DL} + W_{TL}} = \alpha \quad . \quad . \quad . \quad (2)$$

$\alpha$ is defined by Eq. 1 and equals $\rho/(\beta\gamma)$.

However, the decrease in weight of the framing proper depends on the following three factors: the difference in specific weight of the two materials, the difference in allowable stresses for the two materials, and the difference in the total forces in their respective usages.

The following can then be written:

$$\frac{W_{Al}}{W_{DL}} = \frac{\delta_a}{\delta_s} \times \frac{f_s}{f_a} \times \frac{W'}{W} = \beta \times \frac{1}{\rho} \times$$

$$\frac{W'}{W} = \frac{\beta}{\rho} \times \frac{W_{Al} + W_{TL}}{W_{DL} + W_{TL}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Eliminating $W_{Al}$ from Eqs. 2 and 3 leads, after some computations, to the relationship,

$$\frac{W_{DL}}{W_{TL}} = \frac{1 - \alpha}{\alpha\left(1 - \frac{\beta}{\rho}\right)}$$

Then, replacing $\alpha$ with its value in Eq. 1 and using $\frac{W_{DL}}{W_{TL}} = k$,

$$k \geq \frac{\beta\gamma - \rho}{\rho + \beta} \quad . \quad . \quad . \quad . \quad (4)$$

On the graph of Fig. 4, Eq. 4 is represented by almost constant values of $\beta$ and $\rho$ indicated thereon.

The sign of inequality is indicative of the case in which the aluminum frame is less costly than that of structural steel.

Thus, for the numerical values of $\beta$, $\rho$, and $\gamma$ previously determined, the aluminum frame will be less costly than the structural steel frame whenever

$$k = \frac{W_{DL}}{W_{TL}} \geq 1.565 \quad . \quad . \quad . \quad (5)$$

that is, whenever the load due to the dead weight of the structural steel frame is 1.565 times larger than the summation of all the superimposed loads. This, it must be admitted, hardly ever occurs in usual construction. However, the Transportation Pavilion is an exceptional structure which does comply with the requirements of Eq. 4.

The roof deck of the pavilion is designed to carry the following superimposed loads — all in addition to the dead weight of the framing proper:

Snow load, $W_{TL}$ = 35 kg per m² or 7.2 psf.

Skins and hung ceiling = 4 kg per m² or 0.8 psf.

The total is 39 kg per m² or 8.0 psf.

In this case, $W_{DL} = k \times W_{TL} = 1.565 \times 39 = 61$ kg per m² (12.5 psf). That is, for $\rho = 5$, $W_{DL}$ must be 61 kg per m².

What would be the cost of a structural steel framing of this size, erected about 50 ft above grade? Using 20 frs per kg (18 cents per lb) rather than 16 frs per kg (14 cents per lb), it would be approximately

$$\gamma = \frac{U_a}{U_s} = \frac{80}{20} = 4 \quad \text{(instead of 5)}$$

and $k = \frac{\beta\gamma - \rho}{\rho - \beta} = \frac{0.344 \times 4 - 0.88}{0.88 - 0.344} =$ 0.925 (instead of 1.565)

and $W_{DL} = k \times W_{TL} = 0.925 \times 39 =$ 36.1 kg per m² (instead of 61).

Based on the quite detailed computations made, a structural steel frame of 221-ft span, simply supported, and 13 ft deep, would weigh about 53 kg per m² (11 lb per sq ft), which is more than the minimum 36.1 kg per m² above if $\gamma = 4$, but less than the 61 kg per m² using $\gamma = 5$.

Thus it is evident that an aluminum design should be considered if $\gamma = 4$, but not if $\gamma = 5$.

In the case of the Pavilion of Transportation, another special economic factor in favor of aluminum entered the picture. Its temporary nature as an exhibition structure, to be demolished one year after erection, combined with the relatively high salvage value of scrap aluminum to favor the use of this material.

The value of Eq. 4 and the graph, Fig. 4, can be readily appreciated since they make it possible to determine immediately whether or not structural aluminum framing is economical once the structural steel solution $\left(k = \frac{W_{DL}}{W_{TL}}\right)$ as well as the approximate erected unit costs of both metals are known $\left(\gamma = \frac{U_a}{U_s}\right)$.

The great sensitivity of $k$ as a function of $\gamma$ is also evident from Fig. 4, that is, the fact that a small variation in $\gamma$ (the relative unit cost of aluminum) corresponds to a large variation in $k$.

Taking the Transportation Pavilion as an example, it is seen that for values of $\gamma$ between 4 and 5, aluminum framing starts to be economical for a span on the order of 220 ft and for a value of $W_{TL}$ of 40 kg per m² (for the roof deck).

The diagram shows that if $\gamma$ decreases so that its value is, let us say, between 3 and 4, the value of $k$ decreases into the area between 0.284 and 0.925. That is, when $W_{TL}$ = 40 kg per m², the value of $W_{DL}$ is somewhere between 11.3 and 43 kg per m². This area includes a large number of average cases and even of small spans. In other words, it would appear that, in the not too distant future, aluminum will play an important

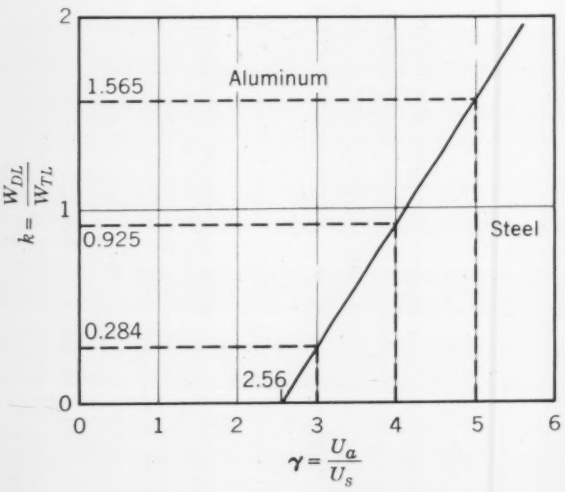



**FIG. 4. Sensitivity of k as a function of $\gamma$ is shown for European practice. Aluminum framing is less expensive than steel in rare cases—such as Transportation Pavilion — where dead weight of steel frame is approximately 1.5 times larger than total of all superimposed loads.**

role in structural framing provided that its unit cost can be reduced by about 20 percent. This does not seem impossible in view of the large hydroelectric power plants now under construction, considering the important bearing that low-cost electric power has on the cost of producing aluminum.

It should not be forgotten, however, that other considerations can influence the choice of aluminum instead of steel, to wit: (1) lower maintenance cost or even no maintenance cost, since there is less danger of corrosion; (2) easier dismantling and greater ease of transportation; (3) reduced weight of columns and foundations; and (4) more pleasing appearance.

On the other side of the picture it should be noted that aluminum is subject to larger elastic deformations (about three times larger than those of steel), as well as larger thermal deformations (about 2.2 times larger). These factors are often important when limited construction depths are the governing criteria.

### Some technical data

The aluminum used for the roof had a specific weight of 165 lb per cu ft, a modulus of elasticity of 10,000,000 psi, and a thermal coefficient of expansion of 0.000013. Allowable working stresses for this material were taken as follows: tension, 16,500 psi, and compression, 18,500 psi. The average weight of the roof framing is 2.2 psf, and this weight, including the skins, is approximately 3.0 psf. This figure is equivalent to 0.25 in. of concrete and is indicative of the extraordinary lightness of the roof deck.

The mild steel for the columns has a working stress of 20,000 psi. The galvanized cold-drawn steel for the ties was considered to have an ultimate tensile strength of 200,000 psi, a yield point (at 0.2-percent elongation) of 172,000 psi, and a working stress of 60,000 psi.

Steel for the springs is rated to have an ultimate strength of 200,000 psi, and a yield point of 185,000 psi.

Snow loads were taken at 7.2 psf.

As for wind pressure, the horizontal wind pressure on the vertical exposure of the roof deck was taken at 4 psf; the horizontal wind pressure on the vertical exposure of the columns, at 19 psf; the uplift pressure on the roof deck, at 10 psf; and the downward pressure on the roof deck, at 7.5 psf.


### Acknowledgements

The architects were H. Montois and R. Courtois, Th. and F. Hoet-Segers, J. Goossens-Bara and R. Moens de Hase. The consulting engineer was A. Lipski. The detailed computations of the roof deck proper were made by A. Sohier. Ateliers Metallurgiques d'Enghien St. Eloi, fabricated the entire framing, which was erected by Firme Carlier et Manandise of Liège. S. A. Sidal of Duffel manufactured the aluminum members while Les Ateliers Mecaniques S. A. Morlanwelz of Hayettes manufactured the springs. Contractor Louis De Waele of Brussels placed the foundation. The entire project was controlled for insurance by the Bureau SECO of Brussels.


## Appendix

What would be the economic considerations and requirements governing such an aluminum structure if it were erected in the United States? In this case,

$$\rho = \frac{f_a}{f_s} = \frac{15{,}000 \text{ psi}}{20{,}000 \text{ psi}} = 0.75$$

$$\beta = \frac{\delta_a}{\delta_s} = \frac{165 \text{ lb per cu ft}}{490 \text{ lb per cu ft}} = 0.339$$

$$\gamma = \frac{U_a}{U_s} = \frac{\$0.75}{\$0.20} = 3.75$$

The value of $\alpha$ is then,

$$\alpha = \frac{\rho}{\beta\gamma} = \frac{0.75}{0.339 \times 3.75} = 0.590$$

Thus, based on a cost for aluminum of 75 cents per lb erected and 20 cents per lb for structural steel erected, the cost in the present American market for a structural steel bar would be 59 percent less than for an aluminum bar, if both bars had been designed to carry the same load. Adopting the same approach as did the author, Mr. Lipski, and using the above United States values for $\rho$, $\beta$ and $\gamma$,

$$k = \frac{W_{DL}}{W_{TL}} = \frac{\beta\gamma - \rho}{\rho - \beta} = 1.265.$$

This means that, in the United States, whenever the load due to the weight of the structural steel framing is 1.265 times larger than the summation of all the superimposed loads, the aluminum frame will be less costly than the structural steel frame.

Applying these values to the Pavilion, if it had been built in the United States:

$W_{TL}$ = 20 psf, snow load (minimum in U. S.)

$$\frac{1 \text{ psf}}{21 \text{ psf}}, \text{ skin and hung ceiling}$$

$W_{DL} = k \times W_{TL} = 1.265 \times 21 = 27$ psf

This means that, unless the weight of the structural steel frame is less than 27 psf, the aluminum frame will be more economical in the United States. It would thus appear, on the surface, that a structural steel frame for a 230-ft span, to be erected about 50 ft above grade, would require more than 27 psf of structural steel. Furthermore, if it can be assumed that the cost of aluminum will eventually be reduced by, let us say, about 12 percent, to 65 cents per lb, erected, and that structural steel will remain at 20 cents per lb, erected, then,

$$\frac{U_a}{U_s} = \gamma = \frac{0.65}{0.20} = 3.25$$

$$\frac{\beta\gamma - \rho}{\rho - \beta} = 1.00 \text{ and } W_{DL} = 1.00 \times 21 = 21 \text{ psf}$$

At this price, for a structural steel frame requiring more than 21 psf, the aluminum solution should be given consideration.

Figure 5, developed for American practice, confirms the great sensitivity of $k$ as a function of $\gamma$ brought out by Mr. Lipski.

It can be concluded that aluminum framing has a potential for shorter spans, in the United States as well as in Europe, as soon as the cost of aluminum can be even slightly reduced.

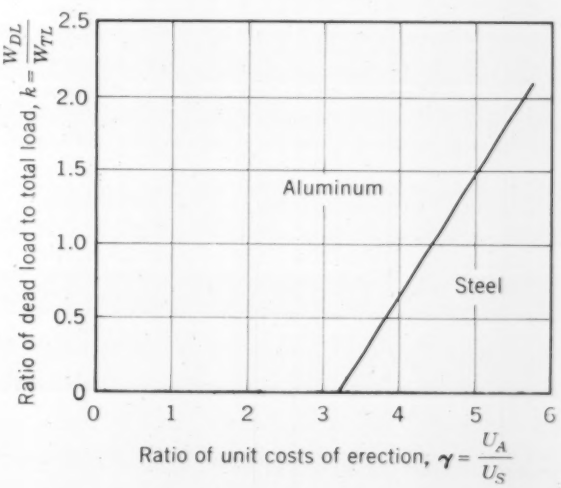



**FIG. 5. Sensitivity of k as a function of γ is plotted for American practice by Charles C. Zollman.**

Prestressed concrete truss of 100-ft span is being tested in a laboratory of Soviet Institute of Concrete and Reinforced Concrete. Past President of American Concrete Institute, Walter H. Price, M.-ASCE, is seen taking notes. He is head of Bureau of Reclamation's Materials Laboratory in Denver.

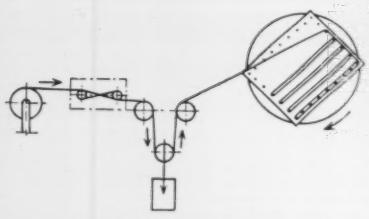


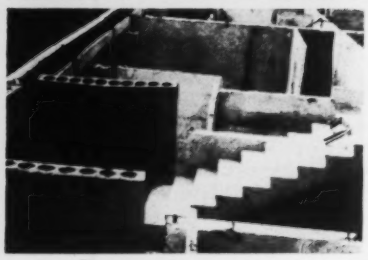
FIG. 1. Production machine for assembly-line prestressing consists of a rotating platform onto which is fed high-strength wire. Flat steel form rotates with platform.

# An American engineer views precast

DAVID P. BILLINGTON, J.M.ASCE

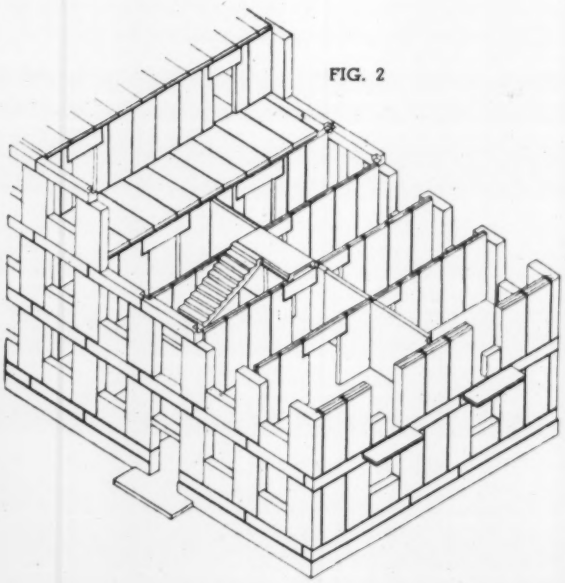
As we circled the Moscow Airport for the first time, one huge white building, gleaming in the sun, stood out from the flat landscape south of the capital city. It was the new Moscow University Building on Lenin Hills where, as our six-man delegation was to learn, only science is taught. The humanities are in old buildings in the center of the city. This emphasizes the concentration on science and technology in the Soviet Union and made a visit like ours, to study concrete and prestressed concrete there, of real value. We were told that 60 percent of Premier Khrushchev's top men are engineers and scientists.

At the instigation of Prof. T. Y. Lin, M.ASCE, the Soviet Government sent five engineers to the U. S. A. to attend the World Conference on Prestressed Concrete in San Francisco in July of 1957. The head of that delegation, Prof. Boris Skramtaev, at that time asked Prof. Lin to form a U. S. A. delegation to return the visit. The members of the delegation were: T. Y. Lin, M.ASCE, Professor of Civil Engineering, University of California, Berkeley, Chairman of Delegation; Boris Bresler, A.M.ASCE, Professor of Civil Engineering, University of California, Berkeley, Secretary of Delegation; Ben C. Gerwick, Jr., M.ASCE, President, Ben C. Gerwick, Inc., San Francisco, and President of the Prestressed Concrete Institute; Walter H. Price, M.ASCE, Chief, Engineering Laboratories, Bureau of Reclamation, Denver, and Past President of the American Concrete Institute; James D. Piper, A.M.-



Standardized precast prestressed elements for apartment houses of four to eight stories are factory made. Completed precast wall panel with window is seen above, and below it assembly of precast elements for building in which walls and partitions are the supporting elements. Fig. 2, at right, shows arrangement of precast units. Below, members of the U.S. delegation inspect apartment-house construction. Left to right: Prof. T. Y. Lin, M.-ASCE; Prof. Boris Skramtaev; Mrs. Wrangall, a Soviet architect; Walter H. Price, M.ASCE; Prof. Boris Bresler, A.M.ASCE; Eugene Sergeev, interpreter; Ben C. Gerwick, Jr., M.ASCE; David P. Billington, J.M.ASCE; and James D. Piper, A.M.ASCE.

FIG. 2



Main building of Moscow's Tomonosov University, where only science is taught, is 32 stories high, tallest building in Moscow.

# and prestressed concrete in the Soviet Union

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The purpose of our visit was to inspect recent advances in the research and development of concrete engineering in the Soviet Union, particularly in precast and prestressed construction. In 11 days we saw a great many phases of Soviet engineering—research laboratories, design offices, production factories, and construction sites.

Most striking was the close interrelationship among research, design, production and construction. In reviewing our observations it becomes most difficult to separate these four phases. This close integration tends to give, on the one hand, a more practical flavor to their research work, and on the other, an experimental approach to their production and construction activity. Based on our observations in the Moscow and Leningrad areas, some general remarks can be made about their system of concrete engineering and several unique examples of their work can be described as illustrations.

Two striking features characterize the Soviet research we observed. First, the emphasis is on the thorough organization of all activities coupled with the ability to concentrate large sums of money in specific areas. Second, the emphasis is on applied rather than on basic research.

All construction work in the Soviet Union is coordinated under the direction of the Academy of Construction and Architecture. There are 22 institutes under this academy ranging from the Research Institute of Town and Regional Planning to the All-Union Research Institute of Manufacturing of New Materials on the basis of fine grinding. We were taken through the Research Institute of Concrete and Reinforced Concrete and the Central Research Institute of Structures, both in Moscow. Nearly all research in the Soviet Union is carried out in such institutes rather than in universities as in our country.

The two institutes visited were located together in a large complex of laboratories in Moscow. By far the more active is the Institute of Concrete Research. There is no single laboratory in the United States to compare with this centralized setup, but if a group of our best were combined they would equal the Moscow complex. The Research Institute of Concrete and Reinforced Concrete is subdivided into 14 separate laboratories. The names shown in Table I indicate the scope of the activities.

The research in prestressed concrete and precast thin shells was most unusual. In one laboratory, directed by Prof. V. V. Mikhnilov, production machines were being developed for assembly-line prestressing. Two types of machines were under development. One consists of a rotating platform onto which is fed high-strength wire. The wire comes from reels, passes through a looping pit where a hanging weight assures a uniform wire tension, then onto metal pins attached to the flat steel form which rotates with the platform. A pantograph controls the pattern of the winding. This is illustrated in Fig. 1.

The second machine employs the same principle of continuous wire wrapping in a controlled pattern, but in this case the form to which the pins are attached is stationary and the stressing apparatus moves. The whole big stressing apparatus runs on tracks and the wire feeder moves transversely to the tracks so that the combined movement, automatically regulated, produces the desired configuration. Later we saw a number of these machines in operation in Soviet precasting factories.

An important phase of Soviet research is their large-scale and often full-scale testing of structural systems. In one of the laboratory buildings a prestressed-concrete truss of 100-ft span was being tested, lying flat. It was covered with gages, and strains were

**TABLE I. Laboratories of the Research Institute of Concrete and Reinforced Concrete**

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|---|
| Theory of Reinforced Concrete and Reinforcement Laboratory |
| Precast and Mixed Reinforced Concrete Construction Laboratory |
| Prestressed Concrete Laboratory |
| Prestressed Concrete Production Methods and Equipment Laboratory |
| Reinforced Construction for Dwellings and Non-Industrial Buildings Laboratory |
| Refractory and Chemical-Resistant Construction Laboratory |
| Special Reinforced Construction Laboratory |
| Lightweight Aggregate and Cellular Concrete Construction Laboratory |
| Dense Concrete Laboratory |
| Cellular and Lightweight Aggregate Concrete and Accelerated Curing Methods Laboratory |
| Refractory Concrete Laboratory |
| Chemical and Physical Research Procedure Laboratory |
| Anticorrosion Laboratory |
| Cement and Aggregate Testing Laboratory |

being measured under post-tensioning loads as it lay on its side. Later it was to be set up in a vertical position for gravity-load testing. Elsewhere in the laboratory a doubly curved thin shell was being built to one-quarter scale for testing. It was a small building in itself. Other items being tested were crane-rail beams with the rail connected to and figured as part of the beam, precast thin-shell units, railroad sleeper frames, and prestressed pipes.

Some more basic types of research were being carried out. Two-year tests on sustained loading of columns were in progress. Also long-term flexural loading of beams was being performed by jacking two beams against each other and leaving them under load for long periods. Bars as large as 2 in. in diameter were undergoing pull-out tests prior to use in pretensioning operations.

After visiting the laboratories we were ushered into the office of V. N. Kartashov, Director, Research Institute of Concrete and Reinforced Concrete, and sat around a long conference table to ask questions and to be asked for our criticisms. Here, beneath pictures of Lenin, Voroshilov, Khrushchev, and a large red banner inscribed with gold Chinese letters, we learned how research is emphasized and carried out to achieve practical results. We were told that a hundred projects were being carried out simultaneously in this complex of laboratories and that if we were to return in three months we would see that nearly all the work had been completed and replaced by new projects.

As is the case with research, the design bureaus also are centralized. Apparently there are no engineers in private practice. They all work for the state. We visited two huge design offices, one in Moscow and one in Leningrad.

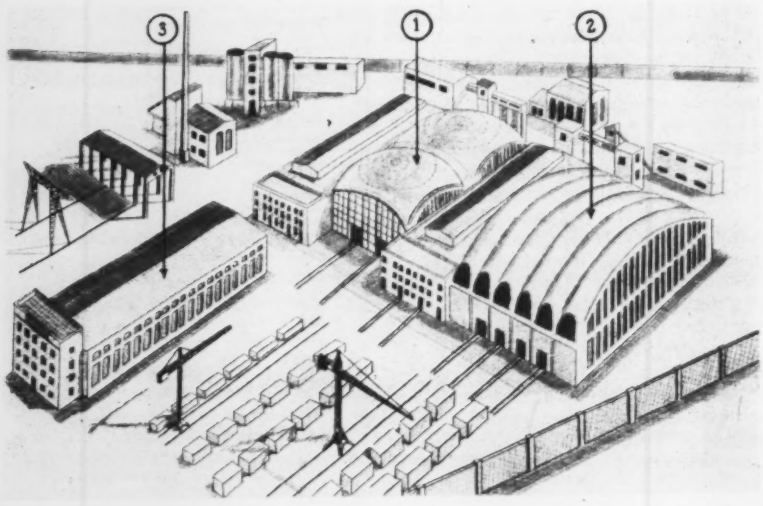
The Moscow Design Bureau is responsible for all building construction in the city and employs 3,100 architects and engineers. The big concentration now is on housing and for that standard designs are developed. Basically the designs employ precast concrete elements as shown in Fig. 2.

The foundations consist of precast spread footings. Grade walls are also precast and rest directly on compacted soil. The superstructure follows one of two lines. In the eight-story apartment houses the frame is made up of precast columns and beams supporting precast panels. Exterior walls consist of large precast panels.

In the second method, for four- and five-story apartment buildings, which seemed to be replacing the taller units, bearing walls are generally employed. There are no columns and few beams. The walls are joined by welding the reinforcing and packing the joints with mortar. Very little lateral resistance is provided because, we were told, Moscow is in a non-seismic region.

All precast panels are standardized and are made in factories. Currently they are in the process of converting their factory production from conventional reinforcing to prestressing. Prestressing, of course, tends to reduce cracking and saves on both concrete and reinforcing steel.

**Avtovo prestressed-concrete plant in Leningrad includes three unique precast concrete structures: (1) twin domes each 133-ft square for roof of one building; (2) huge thin-shell arch roof of 330-ft span on another building; and (3) 100 X 400-ft factory building composed entirely of straight precast elements.**




One feature of Soviet practice seems to be a system of variable factors based on type of structure. In many cases these factors are substantially below ours. One example is the reduced storage live-loads for girder and column design. The New York City Code for example, permits a 15-percent reduction, whereas in Moscow a 50-percent reduction is allowed. There is no increase in the safety factor to compensate for possible overload.

In Leningrad we visited Design Institute No. 1, which apparently concentrates on more unusual projects. There 650 engineers are employed and unlike the Moscow office, which makes designs only for Moscow, only 10 percent of their designs are for Leningrad; the rest are for other areas of the Soviet Union including Moscow where, we were told, they designed the structural frame for the new skyscraper hotel we stayed in, the Leningradskoya.

They seemed greatly interested in space structures. These always are built up of precast and prestressed concrete elements. Large domes, shells, hyperbolic paraboloids, and trusses are being projected. We were shown designs of "standard" domes made of precast pieces connected by prestressing, with spans from 60 ft up to 330 ft square.

We saw two examples of these domes in visits to building sites. In both cases they were serving as roofs for factories in which precast and prestressed concrete products were being produced.

To give an idea of the type of work that a design organization like this is capable of, one large project will be described, the Avtovo factory which we visited as part of our itinerary in Leningrad. Here the functions of research, design, production, and construction really merge together. Three separate projects were seen. First were two domes of 133-ft (square) free span, made up entirely of precast concrete pieces. Second was a huge thin-shell arch roof of 330-ft span made up of 8 units each 25 ft wide with skylights 8 ft wide between. Third was a building made entirely of linear prestressed units. Each building is unique both in the design and in the construction techniques employed.

1. The domes are made up of 135 pieces of 16 different shapes, each weighing about 3½ tons. These curved panels are made in steel forms, assembled on the ground over a steel scaffold, and connected by welding the reinforcing and packing the joints with mortar. The four sides of the dome are supported by precast concrete trusses made up of a series of triangles forming the bottom chord and diagonals. The top chord is formed by the marginal

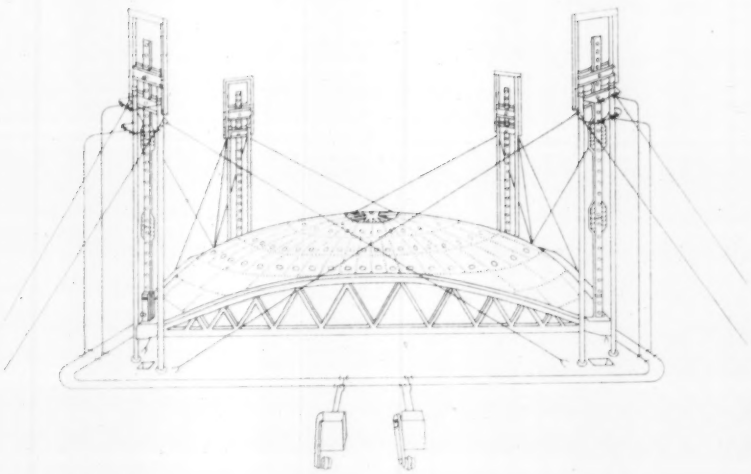


FIG. 3. Precast dome of 133-ft diameter is raised 66 ft by hydraulic jacks to rest on top of four hollow precast columns. Dome consists of 135 pieces of 16 different shapes, seen being assembled at ground level in photo below. Artist's sketch shows completed twin-domed factory building.

ribs of the exterior dome panels. After assembly the trusses are post-tensioned along the bottom chord. Four precast hollow square columns, one at each corner, provide the entire support.

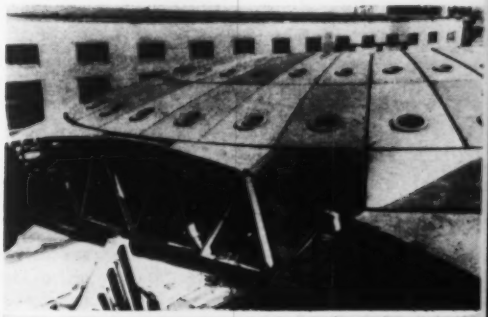
After the 133-ft-square dome is assembled, it is raised 66 ft by jacking at the four corners (Fig. 3), the precast columns are placed, and the dome is then lowered onto the columns. The shell of the dome is only 4 in. thick and the panel ribs are 10 in. deep. The high tension stresses at the corners of this point-supported dome are taken by post-tensioning the precast units of the corners perpendicular to the diagonal of the dome.

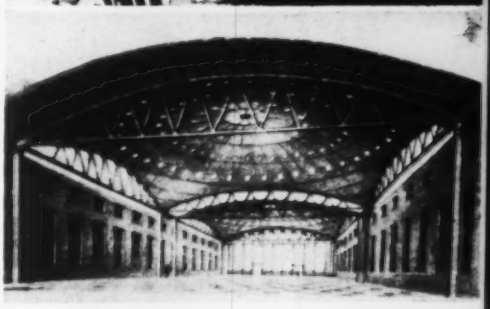
2. Each unit of the 330-ft thin-shell arch roof consists of 13 singly curved panels which are bolted together over a metal scaffolding on the ground. The rise of the corrugated arch shell thus formed is 36 ft. A tension tie is formed between the springing lines of the arch by precast concrete corrugated plates post-tensioned together by cables. One entire unit 33 ft wide weighs 406 tons and has a thickness of 6½ in. of average concrete. The tension tie also serves as the crane-rail support. At the time of our visit the first unit had been assembled on the scaffold and was about ready to be lifted. Cured elements for other units were awaiting assembly.

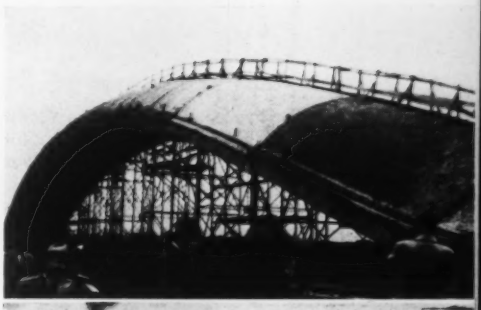
3. The third project (Fig. 4) was less spectacular than the others but appeared to have a much wider application. The building is made entirely of precast pieces. The foundations are precast concrete spread footings. The columns, cast on their side, are composed of a latticework of pretensioned pieces connecting the two main chords by welding and by dowels. The inner chord of the column supports a crane girder, itself a precast truss, about 30 ft from the floor; the outer chord extends to the roof, where it supports a prestressed concrete truss of 100-ft span. The columns and trusses are spaced 20 ft apart. The roof trusses are built of five separate precast panels which are connected together by three post-tensioning tendons, two running the full length of the bottom chord and the other raised up through the exterior diagonals. These tendons were threaded through preformed holes in the concrete. The structure is 100 ft wide and about 400 ft long, with 40 ft of clear height between the floor slab and the bottom of the trusses. The walls for this future precast concrete factory are also precast but with glass block cast in for windows. Even the diagonal wind bracing between columns was made of precast pieces, connected to the columns and to each other by the welding together of plates embedded in both units.

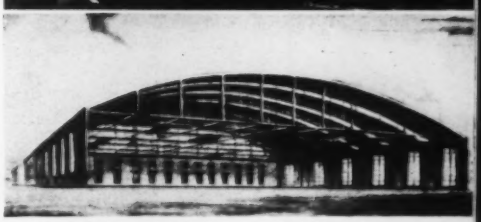
We visited five factories, all engaged in the production of precast concrete structural units. The impressive features of these installations were their high degree of automation, their standardization of products, and their large size. The very nature of their economy permits a scale of planning not known in this country in peacetime. They are able to invest huge sums of money in automatic machinery designed to make certain standard products. They can be sure in advance that such machinery will be fully utilized because the government controls the entire mechanism of supply and demand.

All the factories had been set up for precasting and were in the process of converting much of their production from plain reinforced to the prestressed concrete elements. Prestressing machinery of the type we saw under development in the large laboratory of Prof. Mikhailov was either newly installed or being assembled in each

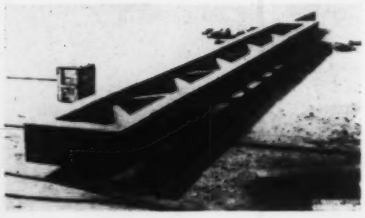




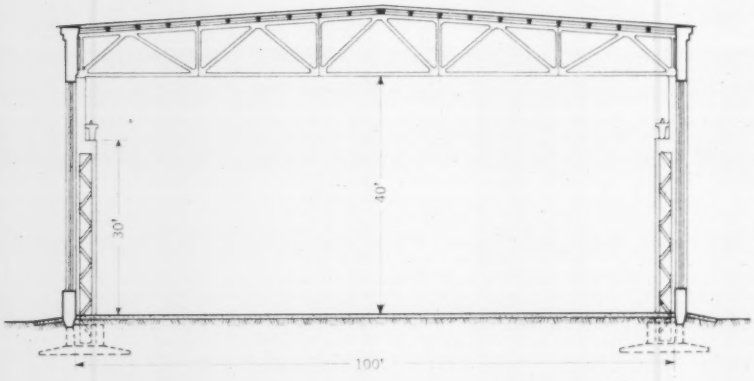




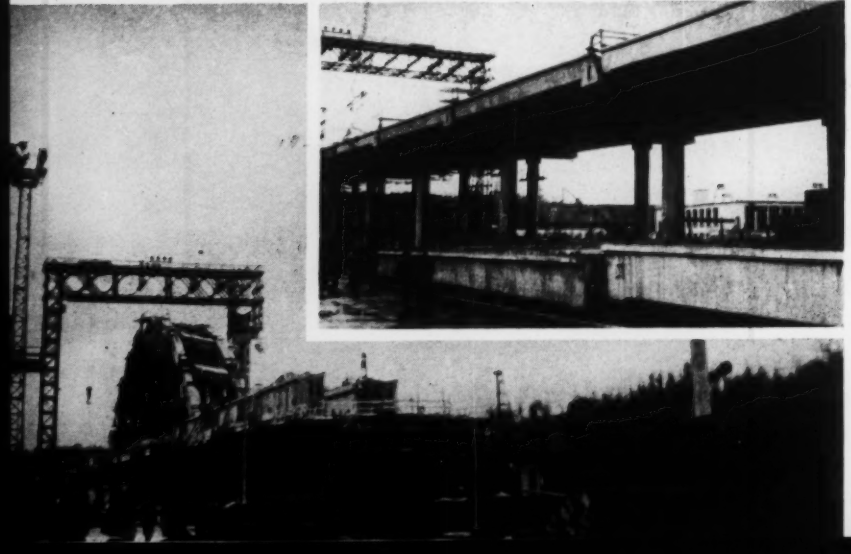
Precasting plant in Leningrad has roof of thin-shell arches spanning 330 ft. One 25-ft-wide element is seen second above, and immediately above, artist's sketch of completed building.



**In a Leningrad factory building, precast diagonal lattice members form combined roof and crane-rail columns. See above left and top right. Precast, prestressed roof truss, half of which appears directly above, right, spans 100 ft. As shown in Fig. 4, below, these elements were assembled into a factory frame.**




**Two-level bridge being built across Moscow River carries both highway and subway. Photo at left below shows, under traveling crane, 5,500-ton assembly, one of which is used on each side of bridge. Precast arches for 360-ft river span were assembled on shore, transferred to pontoons, floated to site, and set in place on piers by admitting water to pontoons. Bottom member is post-tensioned to take arch thrust. For two-level approaches (inset photo), precast beams 75 ft long were used.**



factory. Noting that in each of the plants the prestressing machinery was slightly different, we learned that several separate agencies are engaged in the development and design of such equipment. However, the concrete products were invariably the same. It was evident from the equipment and layout of each plant that the centralized committees permit individual variations in production techniques so long as the product is standard and the quotas are met.

Briefly the layout of the most modern factories followed these lines:

Sand and aggregates are stored in the open and moved by conveyors operating in underground reclaiming tunnels to the concrete mixing buildings. Cement from silos is brought directly to the mixing stations, where electrically controlled batching machinery automatically feeds in aggregates, cement, and water, and mixes the concrete.

The concrete is very dry, usually of zero slump, and travels from the mixer on belt conveyors to empty into hoppers in the factory, which move along overhead tracks to the forms.

Mesh reinforcement is cut, assembled and welded in each plant. Reinforcing cages are made up in the plant and transported overhead. Continuous prestressing is applied in steel forms which run on tracks. Most of the production we saw was of hollow roof, floor, and wall panels for housing. For these, polished metal cylinders are inserted hydraulically through one end of the form to make the voids. Concrete is then dumped from the overhead hopper and the whole assembly is intensely vibrated for about 3 min. In some cases the metal cylinders act as vibrators. In others a metal pad is clamped over the form and compressed into the cast unit under a pressure of about 30 psi.

After vibration the unit moves along the tracks into a long steam chamber, where it remains for from 6 to 12 hours curing at a temperature of about 180 deg F. In one factory the curing was done at 205 deg F. The cured product is stripped and removed to outside storage yards, where overhead cranes store it and eventually load it on trucks for shipment to the site.

The first precast concrete factories were built of structural steel but the new ones are being built entirely of the products they will produce.

The finished products seem to be structurally sound although the quality of the work is not impressive. Quality seems to be sacrificed for speed. In another effort to achieve speed, they are continually trying out new machinery right on the production line. This causes some delays in production but

does permit rapid development and under-fire testing of new and improved equipment.

In the field of concrete engineering in the Soviet Union, factory production and field construction are bound up closely together. Since the supplier and purchaser are the same, there can be close correlation. We visited several building sites where the manufactured items we saw under production were being erected.

Thus the first significant feature of their construction is the dominance of precast factory-made units. This, of course, is important in most of the Soviet Union because of the long season of cold and inclement weather. We saw no ready-mix trucks and very few on-site facilities for concreting.

The second feature of their construction was its mechanization. Imposing gantry cranes, large enough to span over a five-story apartment house, run on rails and erect the many varied and large-size precast pieces. The gantries themselves are built like structures from a huge erector set, with identical interchangeable parts so that they can be reused and adopted to many different building projects. In the housing developments we saw, an assembly-line type of construction was achieved by having one crew do only foundations and utilities and then move on to a new site. The next crew erects the precast panels, the third crew completes the structure, and a final crew does the finishing work.

The precast structures are erected rapidly with a minimum of connections. They apparently provide very little positive lateral resistance. The overall effect of these huge housing developments is drab in appearance but impressive in size and construction methods.

They are apparently concentrating on the housing program, and other phases of construction such as highways are being held off at present. We saw no major highway work under construction, but we were taken to one major bridge project over the Moscow River. This project seemed to be primarily associated with the Moscow subway system rather than with a highway program, although the two-level structure provides for both. Interestingly enough, the design was apparently made by the chief bridge engineer of the ministry of Transportation Construction. We were told that bridges of similar design were being built in Siberia.

The bridge is 4,000 ft long, including the approach spans. Here again extensive use is made of precasting and prestressing. Most interesting however are the design and construction plans for the long-span central crossing of the river channel. The center span is an arch of 360-ft clear span, flanked by two half arches each 150 ft in span. This arched structure, with a total length of 660 ft on a skew of 37 deg, was being built on the shore in two units, each consisting of two complete arch assemblies for the full 660-ft length. The arches are made up of precast pieces connected together by welding dowels, the joints being packed solid with concrete. A horizontal tie connects the two ends of the 150-ft arches at about one-quarter of the rise of the center arch. This tie is also made of precast pieces and is post-tensioned together. One half-section was being completed when we visited the site.

Once finished it will be moved sideways on rails to the river bank and onto timber piers. Two pontoons will be placed under each of the two main supports and the entire assembly will be floated out into position in the Moscow River. During erection the half arches will be tied back to the center span by steel cables which will be removed after the half arches are incorporated into the side-span construction. Each of the main-span units, weighing about 5,500 tons, will be seated on the piers by admitting water to the pontoons. The piers will be of concrete, cast in steel sheetpile cofferdams.

All the approach spans are about 70 ft in length. The foundation support is provided by precast reinforced concrete piles 16 in. square and from 30 to 70 ft long, driven to a design load capacity of 90 tons. The columns are also precast and support precast concrete girders. These girders are made in an L-shape, and are set two per column bent, to form a "U." Cast concrete fills the "U" solid and also ties it monolithically to the columns. Precast stringers rest on the outside flanges of the girders. These stringers are precast as U-beams with light reinforcement. The 37-ton members are post-tensioned in the factory with external cables which are then encased in concrete. The completed stringers, about 5 ft wide and 4 ft deep, are shipped by truck to the site. All these precast units are made in a precast factory which we did not visit. It is specifically attached to the Ministry of Transportation Construction.

Erection of all precast members, including main-span arches, is accomplished with the use of huge gantry cranes running on tracks and spanning the entire construction. In evidence also were high towers with floodlights, emphasizing the three-shift six-day operation typical of all laboratory, factory, and construction work we visited.

Construction of both the Atovo factory in Leningrad and the bridge over the Moscow River shows the great interest in precasting and prestressing in the Soviet Union, and a willingness to experiment with these techniques on projects of considerable size.

As one of the first American delegations of civil engineers to visit the Soviet Union since the war, we were treated with respect and courtesy. Our official host was the Academy of Construction and Architecture of the USSR, B. T. Bechtin, President. Professor Skramtaev personally escorted us in Moscow and Prof. Peter Bajanov, head of the Leningrad branch of the Academy, escorted us while in that city. One great advantage was that our interpreter, Mr. Eugene Sergeev, not only spoke flawless English but is a first-rate civil engineer and knew our field of interest well. Many of the younger men there could speak some English and most of the older academicians spoke French.

The Soviet engineers were most interested in all our work in the United States. They arranged for a series of lectures to be given by our delegation both in Moscow and in Leningrad. These were attended by an overflow crowd in each city, and many questions were put to us by their people. On the last day of our visit, we had a conference with Mr. Vladamir A. Kucherenko, deputy chairman of the Soviet Council of Ministers, and Chairman of the State Committee on Construction. He is in charge of all construction in the Soviet Union. He opened the conference by saying that he did not want to hear our compliments but rather our criticisms. He told us of their plans for huge expansion in the use of precast and prestressed concrete over the next seven years. He stated that an entire institute, which in the past has been designing steel structures only, now has been ordered to design in concrete only.

Our visit was not all engineering. Within our packed schedule of activities, running from about 9 a.m. to 12:00 midnight of each day, our hosts always included some cultural events, such as the ballet, opera, circus, soccer matches, and museums. Perhaps the most dramatic was the trip through the Kremlin, even though the structures are not prestressed. Their cinerama shows a resemblance to ours, except that a five-minute movie of Lenin and scenes of the Revolution was inserted in the middle of it.

Our stay in the Soviet Union ended as it began at the Moscow Airport, where the sleek propellerless jets on which some of us left again emphasized the same theme as the monumental buildings of the Moscow University on Lenin Hills—the importance of science and technology in the Soviet Union.

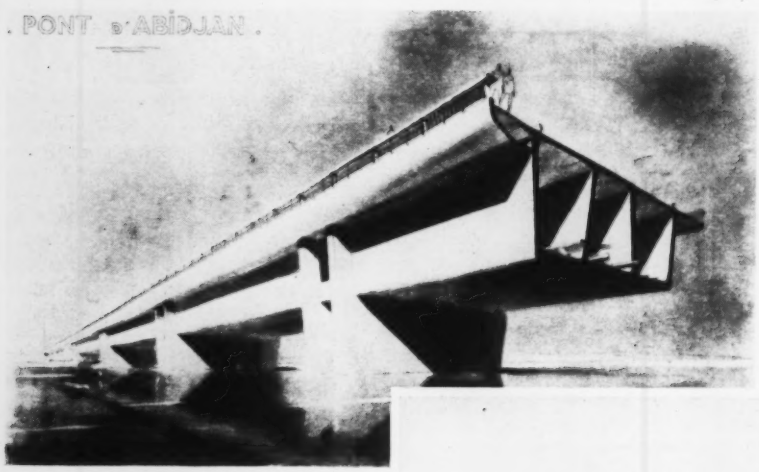
# Prestressed

Bridge at Abidjan spans lagoon between this capital of French West Africa and an adjoining island, which will now share in the city's rapid growth.

Sixteen precast, prestressed box girders, each weighing 880 tons, make up the eight spans of the new bridge at Abidjan, capital of French West Africa's Ivory Coast Province. Each 153-ft span consists of two box girders side by side, each made up of eight precast sections pulled together by post-tensioning. The girders were floated in one at a time and placed on piers supported on deep caisson piles, also built up of precast concrete pipe sections held together by prestressing. For this unusual structure some 25,000 tons of bridge components were cast on shore and most of them floated into position.

The roadway width of 45 ft accommodates 25,000 vehicles a day. On one side is a 13-ft pedestrian walkway and on the other a 13-ft bicycle path. A meter-gage (3.28-ft) railroad track passes through each of the box-girders, which are 19 ft deep. Space between the girders houses utility lines. Recent economic development of the Ivory Coast, mostly since 1949, has made more space necessary in the Abidjan area. Nearby Petit-Bassam Island, formerly reached by a narrow floating bridge across a lagoon, offered space for expansion. But the soil underlying the lagoon is valueless muck to a considerable depth.

At the site there is an average depth of water of 33 ft, then 50 to 65 ft of soft silt, 65 ft of more compact silt un-




Two mammoth box girders side by side, precast and prestressed, make up bridge superstructure. Each box carries a railroad track; center duct provides for utilities. Roadway is on top, with a cantilever on one side for pedestrians and one on the other for bicycles.

Precast concrete elements are used effectively to give architectural interest to pier superstructure.

# concrete units featured in Ivory Coast Bridge

derlain by sand with thin beds of hard clay, and finally a sand-gravel strata of load-carrying quality. Over a length of 700 ft in the central part of the crossing, the load-bearing strata are reached at 165 to 180 ft below water level. The deep foundation problem was solved by installing precast concrete units through lengths of temporary open steel pipe put down to the sand-gravel strata. After the pipe was removed, friction bearing was restored to the units by filling the outside space with grout.

The strata of good bearing material rise sharply at each side of the lagoon until acceptable bearing is reached at a 50- to 60-ft depth nearer the shore. Both the abutments are on land. They were constructed by framing a concrete cutting edge and sinking it by open dredging as concrete was added. Concrete placed by pipe tremie was used to seal the caissons and provide bearing over the entire bottom of the 43 x 82-ft boxes.

### Building the piers

Normal construction sequence is to install the pier foundations first and then build the pier on top of them, but this procedure was reversed at Abidjan. The part of the pier to be above the river bed was fabricated as a floating caisson, towed to position and held there while caisson-type piles were aligned and driven through it so that it served as a template for the driving. Need for having the caisson piles in exact position dictated this procedure, also the fact that all the pier stresses are taken by the caisson piles (Fig. 1).

The pier caissons are open boxes 25 x 57 ft and 20 ft high. They are built with 8-in. walls, and for long life in brackish water are prestressed and have an exterior bituminous coating. These boxes have a weight of 570 tons and would have been difficult to place in the water if assembled on land.

The pier caissons were therefore cast in a novel manner over water near the shore. Four supports were driven and a heavy frame built on top of them a few feet above water. From this, a platform was suspended to support construction operations in the dry. Concrete was placed for the bottom few feet. This section was lowered by four 55-ton screw jacks for partial buoyant support, and an additional lift was added. The process was repeated to completion of the 570-ton unit without exceeding the capacity of the jacks. The platform was dropped and the pier caisson was free to be floated into position for use.

The construction cycle for a pier begins with the assembly and positioning at the pier site of a 330-ton and a 550-ton barge connected by an overhead metal framework with space beneath so that the pier caisson can be floated in between the barges. The assembly is held accurately in position by a rigid steel frame spanning about 140 ft to the adjacent abutment or pier, to which it is strongly connected through a hinged bearing. This permits the floating assembly to follow the 4-ft tide changes during installation of the four vertical caisson-type piles. (The four inclined piles were installed later.) The frame is wide and strong to resist tide and wind forces on the floating assembly and serves as an access bridge as well as a means of positioning the pier caisson almost to the inch.

The four vertical caisson piles were installed by alternately driving and cleaning out an open-end steel pipe 5 ft in diameter, of ½-in. wall thickness, with a reinforced cutting edge. As sinking proceeded, 20-ft sections were welded on until satisfactory bearing material, as determined by the borings, was reached.

The soft material was removed by washing while a hammergrab bucket was used for removal of the harder strata. It could cut through the very compact clay blocks of laterite and wood. Blocking the grabs open made it possible to use the hammergrab as a boring bit, using the Benoto method of rotating the bit with a 23-ft arm that developed a torque of 150 tons.

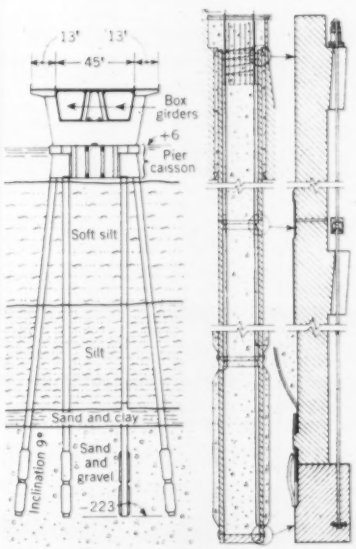



**FIG. 1. Pier superstructure is supported entirely by caisson piles as seen in cross section at right. Details of these piles are next right. Pier construction was started by floating in precast pier caisson and using it as template through which to drive caisson piles—four vertical and four inclined for each pier. After large-diameter steel pipe was driven, precast concrete casing consisting of hollow cylinders was placed inside it. Sections of casing were held together by prestressing wires extending from collar to collar. Then metal pipe was withdrawn and pile filled solid with concrete. Two polyvinyl sleeves at base of each pile were pumped full of grout to develop friction against surrounding ground.**

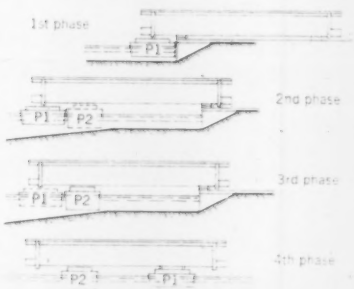



**FIG. 2. Launching of main superstructure elements, 880-ton prestressed box girders, was accomplished in four steps or phases. In first phase one end of girder is carried by barge P1, while other end remains on launching ramp. Second barge, P2, moves inside to provide overhang of girder, needed for placing it on piers at high water by discharge of water ballast from barges.**

While this work was under way, reinforced concrete rings 4.4 ft in outside diameter and 4 in. thick, were cast in 20-ft lengths for installation inside the 5-ft-diameter pipe. The object was to permit recovery of the steel pipe.

The bottom 20-ft section of concrete pipe was closed, and units installed above it were joined to it with watertight joints, so that it remained in equilibrium, floating in the steel pipe. The sections were joined by 28 high-strength 5/16-in. wires that were attached at the bottom and temporarily at the top of each section. The prestress was thus applied in steps, the tension applied at each succeeding collar releasing the pull on the one below to tension the entire column. Twelve sections, making up some 240 ft for the longest casing, were installed in 48 hours. The interior of these caisson piles was filled with tremie concrete. The exterior, except for the two lower sections, was bituminous coated to protect the concrete in brackish water.

There was considerable doubt about the friction value of these piles after the exterior steel pipe had been withdrawn, since it was thought that an annular space might remain open. This was overcome by wrapping expandable polyvinyl plastic around the bottom 40 ft (two sections) of the concrete casing and pumping grout into it to expand the pile against the surrounding material. The polyvinyl was circled by padded soft-iron bands to hold it on the concrete sections. The exterior pipe was withdrawn utilizing the power of the boring machine and two 30-ton hydraulic jacks. Next a pipe installed during assembly was used to force grout into the polyvinyl envelope. Grout return from an air-vent pipe at the top of the section indicated completion of the grouting. When the vertical caisson piles were completed, the floating equipment at the pier box could be released for work on the next pier.

The four inclined caisson piles under each pier (see Fig. 1) are similar to the vertical piles but extend out from each corner on a batter of about 1:10. These were installed in the same way, using as a guide the pier caissons already supported on the vertical piles.

To permit other use of the barges, steel pipe employed for installation of the vertical supports was in some cases used as the pile and filled with concrete to just below the river bed. The precast sections were used at the top as described and the pipe burned off under water for salvage of the upper section.

It is interesting to note that there was substantial verification of the assumption that the soil would contract or compact around the concrete sections after the steel had been withdrawn. This indicates that expansion of the pile tip by grouting may not have been essential.

### Deck precast

Several factors indicated the desirability of precasting the deck sections despite their weight of some 880 tons to be shifted as one unit. Soil of low bearing capacity would require expensive falsework to build the 153-ft spans in place. The required transverse and longitudinal prestressing could be better done in an established shore plant rather than in place over water. And the same prestressing permitted casting the small units that could be tied together for handling.

For casting, a box girder was divided into eight transverse sections, each about 20 ft long. There were two girder manufacturing areas, one on each side of the launching ways. In a two-month cycle, one girder was completed in, and moved out of each area. To cast the eight sections of one girder required a period of one month, using the forms in one area. Forms were specially designed for quick and easy placing and removal. They were moved every three days, or twice in the six-day work week. Early form removal was made possible by partial transverse prestressing to avoid tensile stresses in the still green concrete.

As soon as the eight sections of one box-girder had been cast in one area, the forms were quickly moved to the second area, where the invert reinforcing was already in place. Then assembly of the completed sections and prestressing of the girder began in the first area. Since the end sections would receive the most stress, they were cast first in the concreting cycle to give them a longer time to cure. Transverse prestressing of the girder was followed by longitudinal prestressing. Grout was then injected around the tensioning wires and protection placed over the anchorage heads.

As soon as tensioning was complete, the girder was moved out to free the fabrication area. The girder was raised on to planed timber skids impregnated with a special grease, riding on a concrete sleeper that had a 5/16-in. steel-plate sliding surface. Two 100-ton electric-powered screw jacks moved the girder in 13-ft steps. The sliding force, at start of movement, corresponded to a friction coefficient of 0.15 to 1.20.

A movement at right angles to the first, utilizing the same technique, put the girder in position for loading for water transport. An ingenious four-step method, shown in Fig. 2 was used to transfer the girder to two barges. First, the girder was cantilevered out 16 ft over the water and a barge raised under it by pumping out water ballast, to take the load. Eight temporary cables, prestressed over the deck, counteracted the large cantilever stresses incompatible with the usual stresses in the girder. The girder and barge were pushed out further to permit positioning another barge under it so that the girder would overhang sufficiently to be placed on the pier. This barge took the outer load and the first barge was moved to an inner position.

The floating ensemble was towed into place between two piers at high tide and set as high as possible on the supports. The second girder of the pair was set in the same way. At this level the girders were in the best location to resist the stresses in the steel truss holding the barges in position at the next pier caisson so they were not raised the required 10 ft to final position until later. A precast slab closes the space between the box girders at the bottom to make a utility duct. Deck paving ties the top into a unit.

The project required 34 months for completion. Some 36,500 cu yd of concrete was used in the project, of which about 11,000 cu yd was prestressed. Part of the cement was a pozzolanic blast-furnace material, expected to combat the effect of sea air, locomotive fumes, and humic acid in the mud.

The Abidjan Bridge was designed by the design department of Enterprises Boussiron, following a competition in 1952. The work was carried out by the Société d'Etudes et de Travaux d'Afrique Occidentale and the Société Francaise d'Entreprises de Dragages et de Travaux Publics. Most of the work was done by local workmen, unskilled at the start of the project. A few Europeans helped with the supervision of construction and training of the men.

The entire scheme, with its novel technical and city planning features, which are unique for French West Africa and of interest to all engineers, emphasizes the importance of this bridge of original design.

Most of the information included in this article was obtained from *Travaux* (editions Science et Industrie) for April 1958, published in Paris, France, by the Fédération Nationale des Travaux Publics and its affiliated organizations and the Chambre Syndicale des Constructeurs en Ciment Armé de France. Nicholas Esquillan, Technical Director of Entreprises Boussiron and author of one of the articles in the April *Travaux*, supplied the photographs that appear here. Material has also been taken from the article in the same issue by J. Francois, Chief of Studies, Entreprises Boussiron.

U.S. Harbor at Rota is on Cadiz Bay in southwestern Spain. Tanker pier is at left, breakwater and marginal pier beyond, and ancient town of Rota on peninsula at far right. Inside the breakwater several dredges are excavating the harbor to 35-ft depth.

**STEPHEN M. OLKO, A.M. ASCE**

Consulting Engineer, New York, N. Y.; formerly Chief Port Engineer, AESB, Madrid, Spain

# Navy builds port of Rota in Spain

Principal port of entry for the United States bases in Spain is Rota on the Bay of Cadiz. Here an unused strip of coast is being converted into a $120-million naval installation. Port facilities will accommodate the largest carriers and tankers, and an adjacent naval air station will receive and discharge planes brought in by surface ships. Storage will be available for petroleum fuels to supply a pipeline system extending across the country.

In addition to Rota, minor naval facilities for ship fueling and ammunition storage will be provided at Cartagena on the Mediterranean and at El Ferrol in northwestern Spain. The U. S. Air Force will have airfields near Zaragoza, Madrid, and Seville. See map, Fig. 1. General responsibility for all design and construction work is under the U. S. Navy Bureau of Yards and Docks.

The Port of Rota was located prior to signing of the American-Spanish defense agreement. From old hydrographic charts and road maps this site on the north side of the open Bay of Cadiz was selected because it is partly sheltered by the promontory of Rota and has a natural deep-draft approach with ample turning area. The shore is relatively flat and sparsely populated.

After the American-Spanish defense treaty was signed in the fall of 1953, inspection teams visited the site and approved the location. Detailed data were then obtained for design, such as soundings, tide ranges, currents, wind data, subsoil conditions and sources of materials.

## Laying out the port

Requirements for the port at Rota were a protected harbor with a 2,500-ft turning basin for the largest aircraft carriers, a 1,000-ft wharf that could be tripled in size, and provision for tanker loading and unloading.

The layout (Fig 2) was controlled by factors such as: aligning the breakwater perpendicular to the southwest ocean swells, orienting the piers parallel to the prevailing east-southeast winds, separating the aircraft unloading facilities from the POL (petroleum-oil-lubricants) fuel pier, and balancing dredge and fill quantities. The final layout is a compromise among these factors.

The breakwater protects both the marginal wharf and the POL pier from ocean storms. The inner 2,000-ft section of the breakwater connects with a low-level area on shore and follows the southwest alignment of natural reefs. The outer 5,000-ft section is perpendicular to southwest ocean storms and is slightly skewed to reflect waves towards shore rather than out towards the breakwater head and into the path of approaching vessels. The breakwater head is in existing deep water, where maintenance dredging will be minimized.

A closure breakwater was considered for protection of the interior of the port from local southeast storms. Such a breakwater would also decrease silting in the port area. Since waves generated across the 12 miles of open water between Rota and Cadiz do not exceed 5 ft, a closure breakwater was not required initially, but it may be constructed at a later date if experience proves it necessary.

## Breakwater design

Several alternate designs were studied for the breakwater. The design selected consists of a rock core armored with riprap, tetrapods, and concrete blocks.

Availability of suitable rock was a major consideration. A hard limestone is available from a quarry at El Berrueco, located about 35 miles away. This rock is fissured so that pieces heavier than 7 tons could not be expected in quantity. A quarry of relatively soft rock (specific gravity 2.0 to 2.2) is located 11 miles from the site. A quarry at Arcos, Fig. 1, finally was developed by the contractor by building a railroad.

The breakwater was designed to take advantage of available materials. Rock having a minimum specific gravity of 2.0 is permitted for the core of the structure and is covered with riprap having a specific gravity of not less than 2.6. Since rock larger than 7 tons is not economically available in the area, large concrete armor units were specified for wave protection.

Individual layers of the breakwater are graded as successive filters to pre-

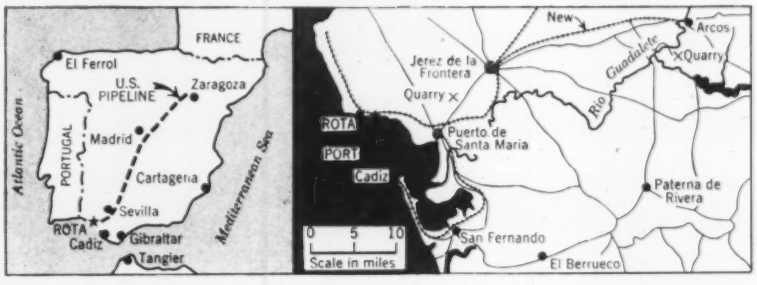



**FIG. 1. Navy port of Rota accommodates largest carriers and tankers, while adjacent air station receives planes brought in by ship.**

vent the washing through of underlying smaller stone. The innermost core consists of well-graded rock varying from 20 lb to 2.0 tons and extends upward from the harbor bottom to about 10 ft below low water. Keeping this core below the water surface reduces the danger of washouts during construction. The contractor was permitted, however, to bid on the option of using the core material up to about 8 ft above low water. Construction could then proceed from shore by end-dumping. This method was adopted.

Armor for the inner section of the breakwater consists of riprap on a 1:2 slope, varying from 3 to 5 tons where wave heights do not exceed 10 ft.

Outer breakwater sections must resist waves 16 ft high. See Fig. 3. It is impractical to employ 7-ton riprap here, as the slope would be extremely flat and, because of the greater depths of water, a tremendous quantity of material would be required. The outer section, therefore, has a "manufactured" armor of precast concrete blocks and tetrapods increasing in weight towards the head of the breakwater. In the more exposed areas, alternate designs were prepared for 25-ton tetrapods on a 1:1.5 slope and 55-ton concrete blocks on a 1:1.75 slope.

Tetrapods are four-pronged precast concrete units developed by the Neyrpic firm in Grenoble, France. The tetrapod design has the advantage of permitting steeper slopes and units of lighter weight. This results from their better "shape factor" and superior absorption of wave energy. The concrete blocks, on the other hand, are easier to form. Bids were taken on either tetrapods or concrete blocks, but not both, primarily to prevent a situation from developing where a contractor would be low on an alternate, but high on the total bid. No bids were received for the concrete-block alternate. The tetrapod design was less expensive.

The tetrapod armor is keyed into a toe berm, which provides a bench for remedial construction. The elevation and gradation of berm material is designed to resist backwash from breaking waves.

The breakwater is capped with a cast-in-place crown wall, behind which heavy rock is placed to prevent undermining. Top of wall varies from El. + 33 ft to El. + 43 ft above Low Low Water. This height is necessary as the design storm is assumed to occur during high water. The crown wall varies in cross section but is designed with a continuous bench 5 ft wide, at El. + 33, to support a crane leg for future repairs to the breakwater.

Armored with 120-ton concrete blocks, the breakwater head serves as the "anchor." This is subjected to waves striking at right angles and therefore each unit must be individually stable since it derives no support from the breakwater mass. The assumption was that the blocks would be cast at the top of the breakwater, then tilted by hydraulic jacks and dropped into position.

After the breakwater design was completed, its entire length and typical sections were studied by laboratory model tests. These tests disclosed that there was a critical area at the center of the outer section, resulting from focalization of southwest waves by offshore reefs. This condition was not clearly defined by the wave refraction diagrams, which were based on old hydrographic charts, as the extent and contours of the reefs were unknown. The model tests employed profiles developed from continuous Sonar readings. The central portion of the breakwater was subsequently strengthened.

Inside the breakwater there is a 1,000-ft marginal wharf. An area 350 ft wide is provided between the wharf and the breakwater for aircraft and general cargo unloading. Several designs were studied for the wharf structure—a relieving platform, reinforced concrete caissons, steel sheetpile cells, and others. Consideration was also given to constructing reinforced concrete caissons in a drydock at Cadiz, floating the units to the site, and sinking them to form a wharf.

A gravity concrete-block type of marginal wharf was selected on the basis of cost and practicability. See Fig. 3. This type of structure is economical and familiar to Spanish contractors. Most Spanish ports, including Cadiz, utilize such construction.

Blocks are placed in a staggered pattern so that each one straddles both the block beneath and that behind. This keeps the entire wall together, utilizing its own dead weight and friction. The resultant earth-pressure thrust on the walls falls within the middle third of each course of blocks, and the lowest course is narrowed to equalize the base pressures. This decreases differential

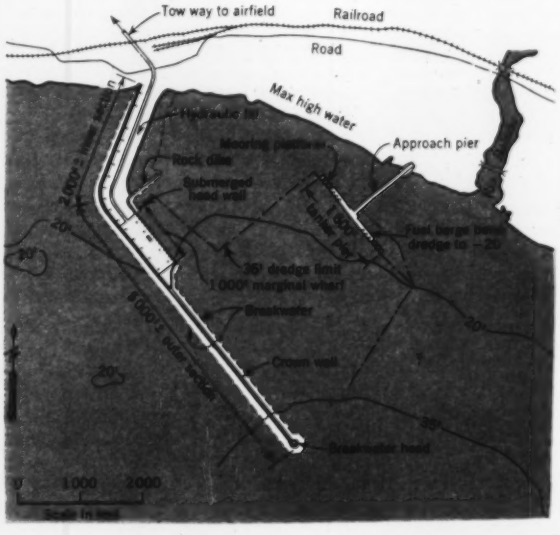



**FIG. 2. Main features of port are inner and outer breakwater, marginal wharf, and POL pier for fuels and lubricants**

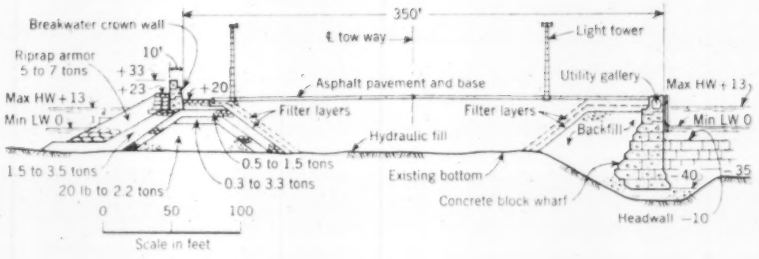



**FIG. 3. Marginal wharf, seen in typical section at right, is connected with breakwater, at left, by apron 350 ft wide, consisting of hydraulic fill topped with asphalt pavement.**

settlements. The narrowing of the base induces shear and tension stresses on the upper projecting blocks. The stresses, however, are low and the blocks are not reinforced.

The blocks bear on a leveling bed of crushed stone and cement in sacks, overlying a base course 5 ft thick to distribute the toe pressures and to serve as a drain for tidal fluctuations. The toe is protected from propeller wash by a heavy cover of rocks.

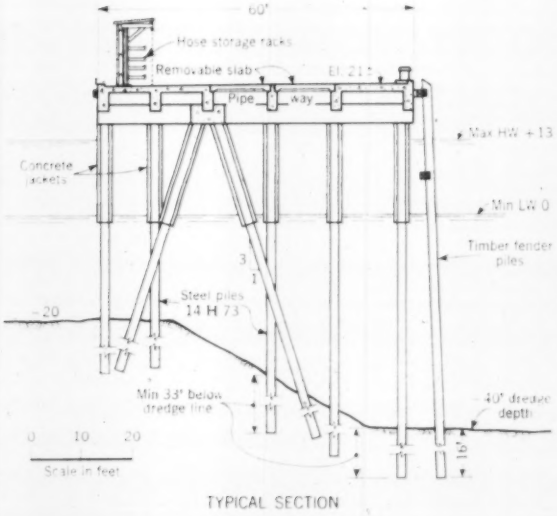
Underlying soil is a compact silty sand. Borings were made along the proposed wharf and samples were tested. The soil can support the gravity walls with ample safety and tolerable settlements. Soil conditions along the wharf are better than in the remainder of the port area because of the close proximity of reefs.

A submerged head-wall is located at right angles to the marginal wharf. The purpose of this wall is to retain fill, alleviate the effects of propeller wash, and serve as a base for future expansion of the port. The top of this wall is 10 ft below low water. Waves therefore pass over the wall and spend themselves on the inner dike. A higher wall would reflect waves back into the harbor, disturbing moored vessels.

The area between the marginal wharf and the breakwater is filled with selected granular material, much of it from hydraulic dredging, to provide a work space 350 ft wide. Unsatisfactory material is wasted at sea. The disposal area is located southwest of Cadiz where water is over 100 ft deep and studies showed that currents would not move the silt back into the Bay of Cadiz.

The soils consist essentially of silty sands with lenses of cemented lime-sandstone and layers of compact clay. Seismic surveys indicate that bedrock is at least 150 ft below the water surface. Since it was expected that the sandstone lenses would be difficult to dredge, the harbor was dredged initially to only 35 ft below mean low water, but the structures were designed for a future dredge depth of 40 ft.

Filter layers cover the breakwater slopes to prevent washing through of the hydraulic fill. All material placed above mean high water is compacted to serve as the subbase for the paved marginal wharf and approach fill tow-way. The pavement is designed for concentrated aircraft wheel loads. Flexible asphaltic concrete is employed as the hydraulic fill is expected to settle.




TYPICAL SECTION

**FIG. 4. Fuel pier is supported by H-piles which penetrate underlying sandstone lenses varying widely in elevation.**

Utility lines are located in a gallery along the wharf face. This gallery is covered with removable concrete slabs, steel gratings, and manholes for easy access. Piping is provided for fresh water, salt water, compressed air, and steam. A cooling salt-water line extends from the head of the wharf to a steam power-plant on shore.

The wharf is lighted from towers. Power outlets along the wharf face are protected by reinforced concrete hoods. There is an electrical substation at the center of the wharf.

Provisions have been made for a future crane and for railroad tracks and fuel lines, the latter to be buried in the fill behind the utility gallery.

A hung timber fender system protects ships berthing alongside. The vertical timbers bear on rubber fender blocks.

### POL pier facilities

The POL (petroleum-oil-lubricants) pier is located at the east side of the turning basin for maximum separation from the marginal wharf. It is a T-head pier having a 1,200-ft approachway and a 1,600-ft pier head, aligned in the general direction of the prevailing winds. The pier will accommodate two of the largest tankers plus a fuel barge of moderately deep draft on the shoreward side.

The 60-ft-wide pier-head consists of several sections. The central section serves only as a pipeway and for access to the two fuel piers, which have three unloading points each. The fuel piers, in turn, are flanked by three mooring platforms connected with steel truss catwalks.

Fuel pipes are provided with guides to prevent buckling due to expansion, and slide over steel channels and pipe sections embedded in the cap beams. Pipeways in some areas are covered with removable precast concrete slabs for convenient access. By covering other areas, the POL pier can be utilized for general cargo facilities.

Hose will be handled by mobile cranes on rubber tires. Racks are provided on each pier for storage of hose and rope. A grounding system throughout the pier is connected to isolated steel H-piles driven into the harbor bottom.

Sandstone lenses underlie the POL pier at widely varying elevations. Steel H-piles were therefore selected for sup-

port of the reinforced concrete deck, since they can best penetrate the lenses and can be easily spliced or cut for adjustment to different penetrations. See Fig. 4. The piles are 12 H 53 for the approach pier, where the water is shallow, and 14 H 73 for the pier-head area, which is dredged to 40 ft. All piles are protected with a concrete jacket extending from the cap beam to 1.5 ft below low water.

Construction of the POL pier began before the protecting breakwater was completed. The design of the pier was therefore based on construction in the exposed open bay, working out from shore. The bent spacing of about 16 ft (5 meters) was selected as the maximum practical advance for a pile driver working over the structure.

The fender system consists of treated timber piles spaced 8 ft on centers. Consideration was given to a massive gravity fender system, but this proved too expensive.

Contract plans and specifications were prepared in both English and Spanish, based on U. S. Navy design criteria, using the metric system. The Spanish engineers proved to be very competent and, with their excellent background, rapidly adapted themselves to U. S. methods of work.

The initial work in London was accomplished under Capt. A. C. Morris, CEC USN. The work in Spain was under the direction of Admiral Robert H. Meade, M. ASCE, CEC USN, formerly chief of the U. S. Navy Bureau of Yards and Docks.

Designs were prepared under the supervision of Architects-Engineers Spanish Bases (AESB), a joint venture of four American firms: Shaw, Metz and Dolio of Chicago; Metcalf and Eddy of Boston; Frederic R. Harris, Inc. of New York; and Pereira and Luckman of Los Angeles. E. J. Quirin was chairman of the AESB group. J. T. Stofko and F. R. Sherman were Project Manager and Deputy Project Manager of AESB, respectively. Hal W. Hunt was Project Manager for the Rota complex. All are Members, ASCE.

P. D. G. Hamilton, M. ASCE, was the Chief Port Engineer and the author was his assistant, succeeding him when he returned to the U.S.A. The author spent two years in Spain and was later succeeded by E. Abonyi.

Detailed contract plans were prepared under AESB supervision by Estudios Technicos Urquijo of Madrid. Wave and breakwater studies were made by Dr. Ramon Iribarren Cavanilles and Dr. Casto Nogales y Olano of Madrid. Model tests were performed by the Laboratoire Central d'Hydraulique de France of Maisons-Alfort (Seine) near Paris.

# Harbor construction

**ROGER H. CORBETTA,** President, Corbetta Construction Co.,

**HAL W. HUNT, M. ASCE,** Executive Editor, *Civil Engineering*;

Making and moving big units of concrete and handling a lot of rock are the major construction problems in building a harbor for the U. S. Navy at Rota in southwestern Spain. The U. S.-Spanish joint-venture, Corbetta Construction Co. of New York and Construciones-Civiles of Madrid, supply their own equipment on this project, much of which is unusual in American practice. A general description of the U. S. Naval Base at Rota is given in the preceding article by Stephen M. Olko.

More than ten thousand tetrapods, weighing up to 27.5 tons each, are placed on a rock breakwater face to absorb the force of the waves. Concrete blocks weighing up to 122 tons each, are cast on shore and moved to position in a marginal wharf that will accommodate the largest ships of the U. S. fleet. Even larger concrete blocks are transported to the head of the 7,000-ft-long breakwater.

Hard rock had to be dug out of the harbor area to provide a 35-ft depth but the dredged material is so mixed with muck that most of the 5 million cu yd has to be wasted at sea. While dredging is being done, some 1.5 million cu yd of rock is being hauled out from land quarries to build the breakwater, which has a base width of 260 ft and a height of more than 50 ft at its outer end.

Dredging has proved to be unexpectedly tough. A cutter-head suction dredge can take out muck and some mixed material but most has to be dug with ladder-type bucket dredges. Much drilling and blasting, not originally contemplated, has been necessary. Despite this, only a small amount of granular material has been salvaged for use in the permanent structure.

Half of the 1.5 million cu yd of stone in the breakwater can be a relatively soft material for the core, available with an 11-mile truck haul. Trucks haul this directly out on the breakwater, keeping the core of the fill ahead of the armor placing.

All rock exposed to wave action has to be heavy, wear-resistant stone, and an extensive search was required to find such rock, but it was finally located 45 miles away. It was then necessary to build 28 miles of railroad to transport it. The latter was made practical by an existing right-of-way. Before 1929 the Spanish had constructed the bridges, done the grading and built the stations but steel was short and no rail was ever laid. Corbetta-Coviles completed the railroad and supplied big new American Locomotive Co. diesel engines, costing $275,000 each, to augment the Spanish equipment. Hauling charges are applied against the cost of the locomotives so that the railroad eventually will acquire the equipment.

At the rail terminus on the waterfront two stiff-leg cranes, with 120-ft booms, separate the rock into the several required sizes for truck transport to the breakwater. The cranes straddle two lines of track and are mounted on traveling bogies to permit covering a large storage area. Trucks with a short wheelbase are used for hauling out on the breakwater to facilitate turning on the narrow top of the structure. In so far as possible the trucks dumped rock where it would roll or slide to position.

The problem of placing 8-ton rock and 8.8- to 27.5-ton tetrapods at a distance of up to 125 ft from the center of the breakwater is handled by a full-revolving, hammerhead-type crane. This huge rig has a 360-hp diesel-electric generator mounted on its gantry to supply electric power for traveling, hoisting, swinging and lighting without external connections. The 400-ton unit travels on double rails on wood ties. The double rails are spaced 20 ft apart on centers since this is the maximum space available. See Fig. 1.

An auxiliary leg on the rig, 20 ft further out, is set down to give added stability when handling heavy loads at some distance out. A basket made of rail is used to transfer a truck load of stone to final position. The time cycle is 3 min for moving a load to the outer end of the rig. This crane was made by Paindavoine of Lille, France, especially for the job at Rota, and has proved quite satisfactory.

# for U. S. base in Spain

New York, and Corbetta-Coviles, Rota, Spain

formerly Chief Engineer, Corbetta-Coviles, Rota, Spain

All weights and dimensions on plans for the project are metric. English units given here are approximate.

Tetrapods come next. They are cast on the job in steel forms made in four identical units. One section of form was anchored to the ground and the others attached to it by quick-acting clamps. All forms are located in a double circle under a stiff-leg derrick, which moves the forms and places the concrete. Forms are stripped and used each day. Concrete is prepared in a British Winget plant that has storage capacity for 500 tons of aggregate, cement and pozzolan to feed two 2-cu yd tilting mixers. The concrete is distributed by Dumpcrete trucks.

While easy to cast, the tetrapods are ungainly to handle and require a lot of space for storage as they do not stack. A Westinghouse–Le Tourneau 35-ton Tournacrane with big tires moves the tetrapods from the casting bed to storage on soft sand or on beaches, sometimes into shallow water. More than 4,000 of the 10,000 tetrapods were in storage at one time, parked in every available place. For most of the tetrapods, handling hooks are avoided to save steel and eliminate spalling of concrete from corrosion. Instead, a cradle picks up each tetrapod, putting all concrete in compression, for original handling from the storage bed. The smaller tetrapods are hauled to the breakwater two at a time on a flat-bed truck but the 27.5-ton units are set singly on a special cradle on a truck. Tetrapods are swung into position by the Paindavoine crane using a single cable, set to unhook readily.

A crown wall up to 30 ft high is cast in place on top of the breakwater. Tetrapods are piled halfway up its exposed side to absorb the wave force as completely as practical. The only equipment capable of handling the tetrapods to the outside position is the Paindavoine crane so the crown wall has to be kept close up to the armor rock placing to permit the big crane to perform all its functions with a minimum of reverse travel. Simple steel forms are used for the wall, set in one unit for a maximum 20-ft lift and 35-ft advance. To hold the concrete and provide a level start for the form on the rock fill, a dry masonry wall is laid as a base for the forms. The Spanish are quite adept at masonry wall construction so building it is rapid and economical. Concrete, delivered by Dumpcretes from the central plant, is placed by truck crane and bucket.

The Paindavoine crane remains some 500 ft behind the end of the breakwater-head construction to allow wave action to settle the newly placed fill before moving the crane over it or constructing the concrete wall. The crane places the outer armor rock and tetrapods up to about 100 ft in front of the wall construction, completing placement except for the space immediately adjacent to the wall. After a 35-ft wall section is concreted and the forms removed, the crane returns to place the remaining rock or tetrapods against the wall.

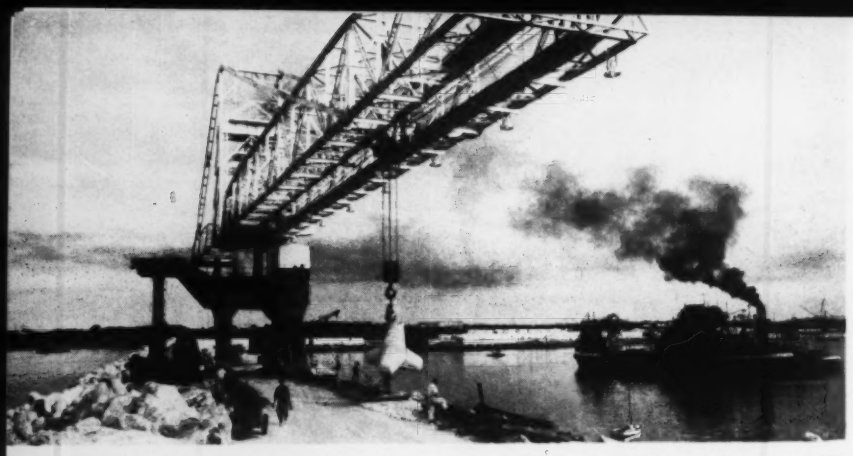
Most unusual in American practice is the marginal wharf, made up of large concrete blocks cast on shore and placed by floating equipment. The original plans called for 2,485 blocks each weighing from 38 to 66 tons. The latter was the largest size the designers expected the equipment available could handle. But it was found practical to handle much larger blocks so the marginal-wharf blocks were rearranged as shown in Fig. 2. This reduced the number of blocks to 1,362 and eliminated the making, storing and setting, mostly under water, of more than 1,100 units.

A gantry crane of 82-ft span that could pick up a 122-ton block, travel with it at 30 ft per min and deliver it 25 ft outside the gantry on a barge, was the key equipment for casting. A stiff-leg derrick, of 15-ton capacity, transferred forms and placed concrete so that the gantry could be used most of the time for moving blocks from the casting area to storage and from storage to a barge for transport to point of placement.

Blocks were very accurately cast in steel forms, some as large as 11 × 18 ft and 8 ft high. Forms were made heavy and rigid so that no interior ties were required. The blocks were cast 2 in. narrower than the theoretical to allow for inaccuracies in casting and placing. Actually the blocks were so accurately made and positioned that gaps were only ¾ to 1 in. wide and filler blocks had to be used to complete the required length.

Blocks rest on a prepared bed of crushed stone in an excavated trench. The stone was dumped from barges and leveled under water by dragging a screed along accurately positioned rails as divers checked the operation. Fine

**Core rock and some armor rock is dumped from trucks ahead of hammer-head crane. Big crane must place tetrapods outside concrete wall after it has been built.**



**Crane, made by Paindavoine in France, places 25-ton tetrapods at a distance of 125 ft out on a 3-min. cycle. Unit has its own 360-hp diesel-electric generator to supply power for all operations.**

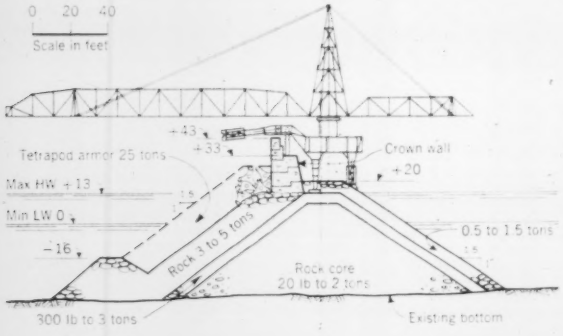
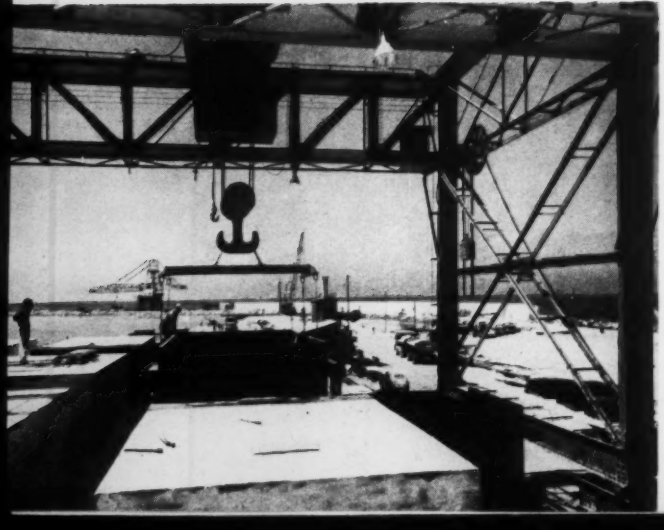



**FIG. 1. Crane weighing 400 tons was moved out on breakwater core to place armor more than 125 ft out. Auxiliary leg served as outrigger for crane.**

**Blocks weighing 122 tons could be handled on land only by a big gantry that spans casting and storage yard. Gantry loaded blocks on barge from overhang at right.**



**Steel forms without ties are used to cast concrete blocks weighing up to 122 tons.**

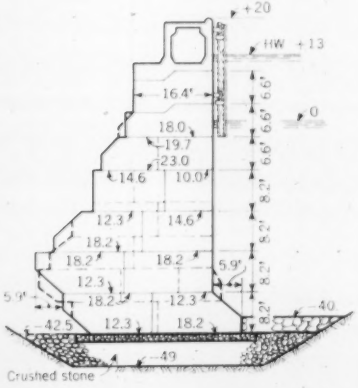
**FIG. 2. Original design of wharf wall (dotted lines) required 2,485 blocks. Revised design required only 1,362 blocks, but some weigh 122 tons.**

aggregate was used for final leveling to assure a perfect bed for each block. See Fig. 3. The blocks were placed from the hull of a cutterhead suction dredge. The "ladder" was removed and the ladder support used as a stiff-leg A-frame. Anchor lines on the hull were fixed in deck winches that were remote controlled from what normally is the dredge-man's perch. These lines were used for all movement of the rig. First the A-frame was moved over one of several blocks on a barge. A pick-up device was lowered into slots cast in the block and turned 90 deg. Safety wedges were positioned along the pick-up to prevent accidental freeing of the pick-up device.

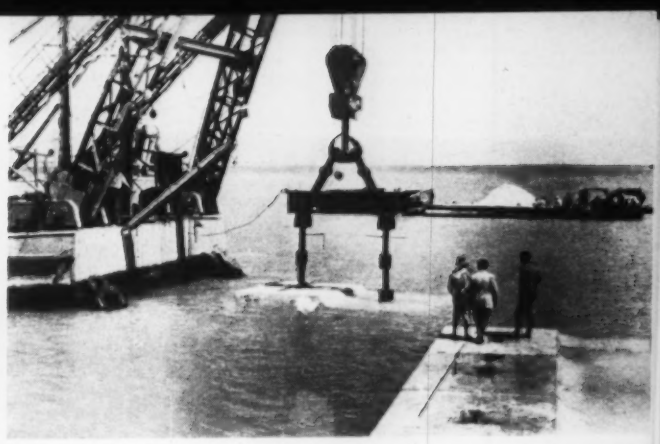
The block was lifted from the barge and then lowered as the hull was maneuvered into exact setting position by the anchor lines. Divers checked the final position of the block, and it was released. This method permitted placing as many as 15 of the 90- to 122-ton blocks in an 8-hr shift. More than 1,300 blocks were set in 8 months, including a 6-week period in which none were placed. A major factor in achieving this speed is moving the entire floating unit instead of swinging or "booming" the lifting frame. That would have changed the barge balance and required considerably more maneuvering.

The wharf wall, odd-shaped to equitably distribute bearing on the soft underlying soil, was backfilled with granular material. Specifications required that initial settlement be permitted to occur before the casting, in place, of the utility gallery that forms the top 10 ft of the wharf face. Careful measurements showed that the block wall became stabilized in 16 weeks after the blocks were set to full height. This reinforced concrete wall tied all the blocks into a unit and provided beam action to take the pull of hawsers from the big carriers.

The wharf is nearing usable completion. Soon aircraft that cannot fly the Atlantic or take off from a carrier can



Pick-up for blocks is lowered into slot and rotated 90 deg to lock. Wedges are placed alongside stems to prevent accident. All can be released from the surface.



Entire derrick boat, with fixed A-frame, moves as a unit for setting as many as 15 blocks in 8 hours. Despite size, blocks fitted well within the allowable tolerance.

be brought alongside on ships, set on the wharf and towed a mile to the Naval Air Station, where they will be put in service.

Already in operation is a POL (petroleum, oils and lubricants) pier, a mile away but inside the protection of the breakwater. This H-pile-supported concrete-deck pier is designed to accommodate tankers of up to 40-ft draft and to transfer their cargo to a 1.2-million-gallon tank farm on shore. From there the products are pumped some 700 miles across Spain to service all of the U. S. airfields.

Piles were driven from a job-assembled floating rig with swinging leads 85 ft high to accommodate a 1.3 batter. Rock penetration was expected to be tough but an S 8 McKiernan-Terry single-acting hammer of 26,000 ft-lb energy successfully drove the 14-in., 73-lb piles.

The piles are required to have a concrete jacket to below the low-water level and to have the form in which they are cast left on. Thin-gage sheet metal was welded on the job into a "can" with a bottom closure of ¼-in. plate cut to the H-shape. Rod hangers welded to the bottom plate and looped over the top of the H-pile supported the concrete during tremie placing.

Timber falsework for the concrete deck was supported on a ⅜ × 6-in. steel collar clamped around the pile encasement to carry a 25-ton load at each pile. The collars, with brackets to support the "stay-lathing," had two 1-in.-diameter pins welded on so that they extend 1 in. through holes burned in the encasing "cans." They were placed prior to concreting and retightened before loading. Computations indicated that the collars would not carry the load but a field test with a 150-ton jack, on hand for pile testing, proved them good for more than 50 tons with ½-in. strap and 40 tons with the ⅜-in. strap used.

The deck was formed on timbers that could be dropped into the water in stripping and floated ahead for the next use. Concrete from the central plant was distributed by buggies from Dumperete trucks that ran out on the structure as far as construction permitted.

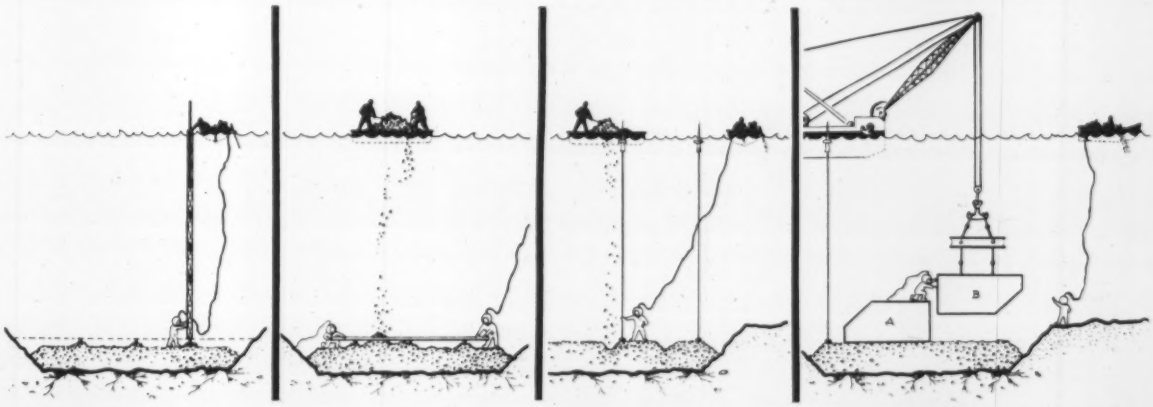
For Corbetta-Coviles, John A. Tantillo is project manager and Jose Parada, assistant project manager and chief engineer. George Caneva is superintendent and R. O. Camozzi is in charge of the quarries. Don MacLeay is project engineer and Jose Preysler, office engineer.

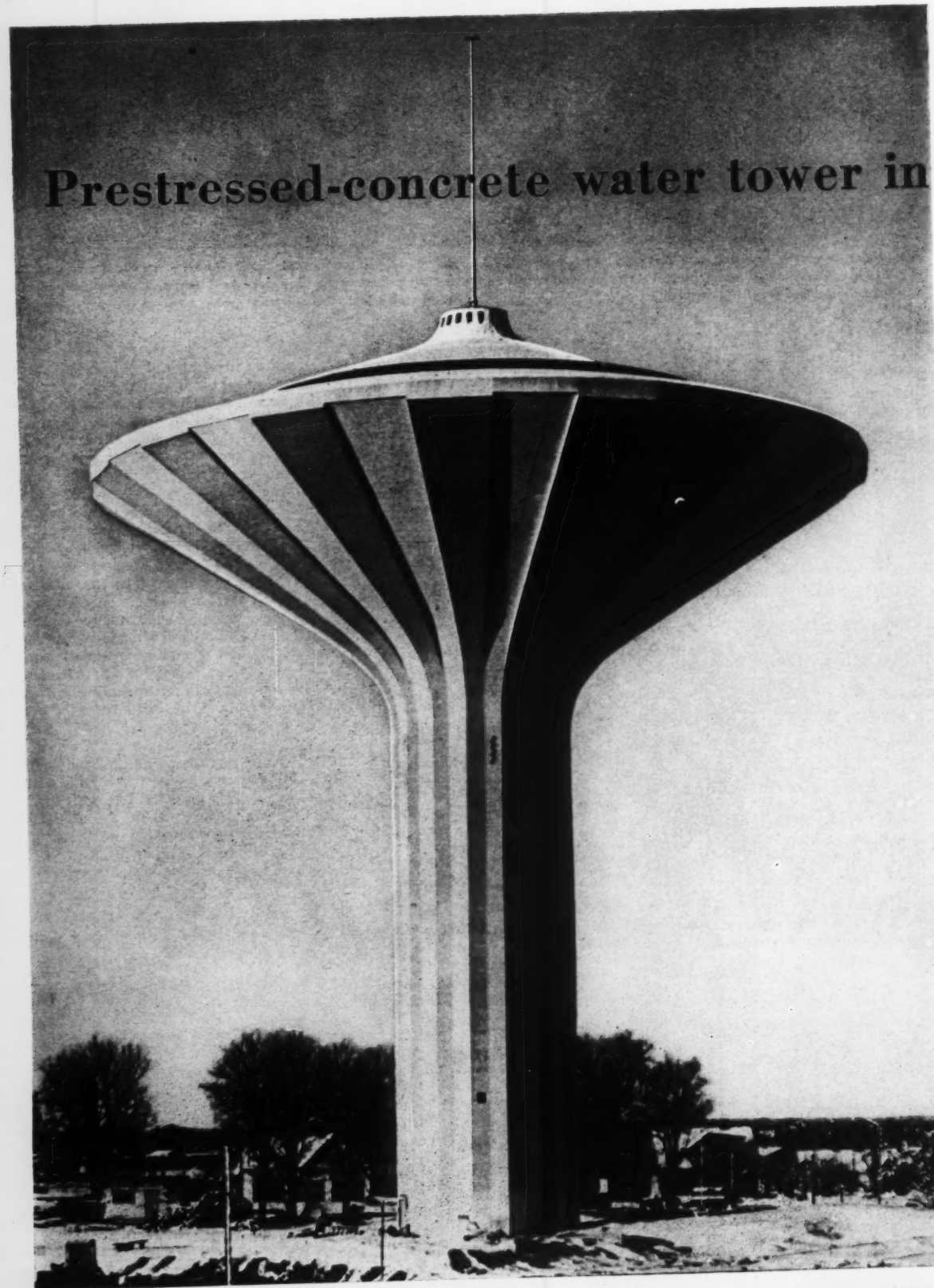
Société Dumez of Paris holds a subcontract for the dredging, placing of the breakwater rock and tetrapods, and setting of the marginal wharf blocks. This work has been done under the direction of J. Fournier.

Supervision of construction is handled by Brown-Raymond-Walsh for whom P. L. Hamilton is project manager at Rota and H. N. Hockensmith directs all work in Spain. Plans were prepared by AESB as noted in the preceding article.

The U. S. Navy Bureau of Yards and Docks is represented at Rota by Cmdr. R. C. Gordon, under Capt. Dean Carberry, Officer in Charge of Construction in Spain. All work on the Spanish bases is under the direction of the Joint United States Military Group, now headed by Maj. Gen. S. J. Donovan.

FIG. 3. Bed for the marginal wharf wall was prepared by dumping stone on the compacted silt and leveling by divers. Beams made track for screed rail. Buoys show where to dump stone to fill recesses left by removal of rail.




Prestressed-concrete water tower in

**Prestressed concrete water tower in Orebro, Sweden, combines elegance with utility. Its cost was no greater than that for a conventional structure of the same capacity and height, if special facilities are considered.**

# Orebro, Sweden

**KURT ERIKSSON,** Civil Engineer, A. B. Vattenbyggnadsbyran, Consulting Engineers and Architects, Stockholm, Sweden

The recently built water tower in the city of Orebro, Sweden, has a central location which necessitated an effective architectural design. Because of its large volume, 9,000 cu m (2.4 million gal), and its height, about 50 m (160 ft) between the ground and the high-water level, a conventionally designed cylindrical reservoir supported by columns or cylindrical walls was considered too bulky. With the aid of prestressed concrete it was possible to create a more slender and elegant structure. The shape eventually adopted was developed gradually from earlier designs.

As can be seen at a glance from the vertical section shown in Fig. 1, the structure is very economical with regard to material. On the other hand, the scaffolding for the reservoir involved serious problems and a substantial cost.

## Structural considerations

The outer reservoir wall, which is prestressed horizontally, is conical with a slope of 1 vertical on 1.5 horizontal. The main dimensions are shown in Fig. 1. The maximum diameter is about 46 m (150 ft). The outer surface is polygonal with thirty-two faces. Every other one of these faces projects 20 cm (8 in.) in order to provide for anchorage of the prestressing cables. The wall has no insulation.

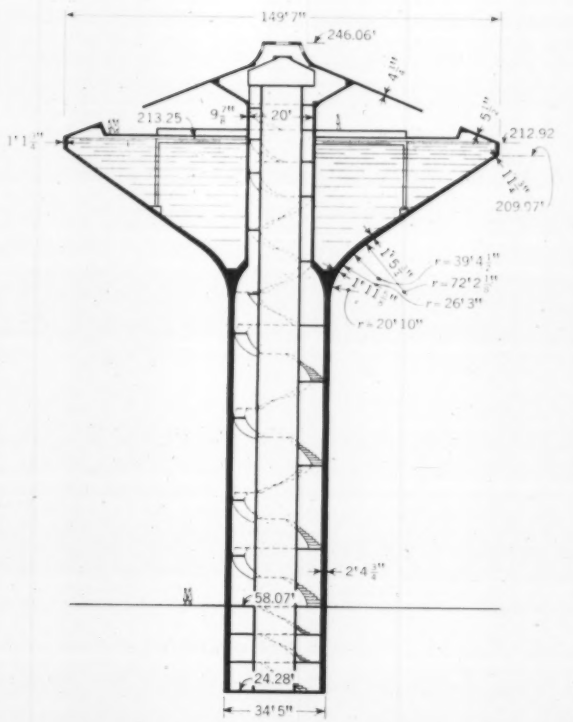



**FIG. 1. Orebro Water Tower, seen in vertical section, has a reservoir capacity of 2.4 million gal. Total height above foundation, excluding mast, is 223 ft and maximum diameter is about 150 ft.**

Special attention was given to handling stresses at the transition between the conical shell and the stiffening foot-ring at the bottom of the reservoir. The influence of the double-curvature transition zone chosen is illustrated in Fig. 2. The weight of the water and of the shell above and outside of a horizontal section creates a meridional compression. If a ring element in the transition zone is considered, the meridional compression has an inward resultant, which counteracts the water pressure on the ring. By a suitable choice of the radius of the meridian, a resultant compression in the ring can be obtained. As the previously mentioned foot-ring is also subject to compression, the boundary effects on the different structural elements at the bottom of the reservoir are moderate. A model test of the reservoir wall and foot-ring verified the analyzed structural behavior. The transition zone also contributes to an architectural impression, which is in full conformity with its structural function.

The inner wall of the reservoir is a cylinder with a sliding joint at the base.

The supporting cylindrical stem has an outer diameter of 10½ m (34 ft 5 in.). Because of a deep fault in the rock, the foundation had to be blasted down some 10 m (33 ft) below ground level. Grouting had to be done another 20 m (65 ft) below the foundation in order to consolidate the rock. In the three basement levels so obtained, there will be a furnace room, a storage area, a valve chamber, and other facilities. The cylindrical stem also encloses a staircase and a concrete cylinder, which contains two elevators, each with a capacity of ten persons.

For radio and television purposes, two rooms have been provided in the cylindrical stem, and a mast has been raised on top of the structure.

The central part of the roof structure

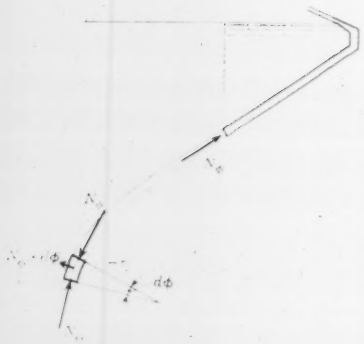
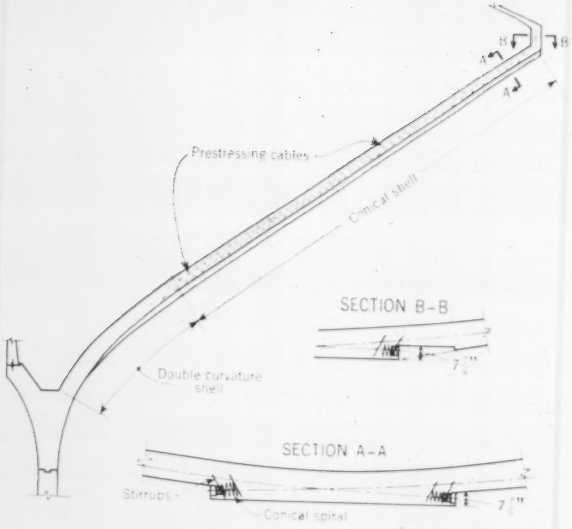


FIG. 2. Meridional forces acting on the reservoir wall and their influence on a ring element are shown diagrammatically.

FIG. 3. Distribution and anchorage of prestressing cables are such that no ring tension occurs for any combination of loads, including temperature and shrinkage effects.




is designed to house a restaurant. The roof of this structure consists mainly of a conical shell, supported by another conical shell (Fig. 1). The restaurant floor is supported by thirty-two prefabricated, pretensioned radial beams which rest on the inner reservoir wall and on a cylindrical row of similar columns, standing on the reservoir wall. Outside the restaurant there is a lookout balcony. The outer edge of this is suspended in a conical shell, which forms the outer part of the roof. The thickness of the roof shells is generally 0.12 m (4¾ in.). They are not prestressed, but the vertical ring that connects the outer portion of the roof with the conical reservoir wall is prestressed horizontally.

The roof structure has been designed architecturally to conform with the monolithic impression of the whole water tower. The tower is painted with a cement paint in white and light grey.

## Prestressing work

Distribution of the prestressing in the outer reservior wall is shown in Fig. 3. The zone of double curvature is subject to compression and needs no prestressing. The prestressing has been designed so that no ring tension occurs for any combination of loads, including temperature and shrinkage effects.

With regard to the prestressing system, the contractor had a free choice but the total prestressing force and the distribution were given. The Freyssinet system was chosen, the cables consisting of twelve wires, each with a diameter of 7 mm (0.276 in.). The wires had a breaking stress, $\sigma_B$, of 150 kg per sq mm (215,000 psi) and a 0.2-percent proof limit stress, $\sigma_{0.2}$, of 125 kg per sq mm (180,000 psi). The losses of stress due to creep, shrinkage, and friction were calculated essentially according to the German standard specifications Deutsche Industri Normen 4227, and test results. The coefficient of friction was assumed to be 0.35.

Wires were tensioned to about 115 kg per sq mm (165,000 psi) before the locking operation. This comparatively high value could be used because the nature of the structure excludes the risks of essential overloading and of fatigue. The cable force averaged some 37 metric tons (1 metric ton = 2,200 lb) after deduction for all the losses.

Every ring, marked on Fig. 3, consists of two cables overlapping each other at the ends. The total number of cables is 206, and the longest cable is 76 m (250 ft).

The number of anchorage locations, projecting 20 cm (8 in.), could have been limited to 4 or 8, but 16 areas were preferred for architectural reasons. The cables in the top of the ring were anchored in recesses, which were filled with concrete after the tensioning.

Tensioning of the cables was done in two stages. In the first stage, which was carried out as soon as possible, some 20 percent of the cables were tensioned in order to induce compression in the concrete and prevent cracking due to shrinkage and settlement of scaffolding.

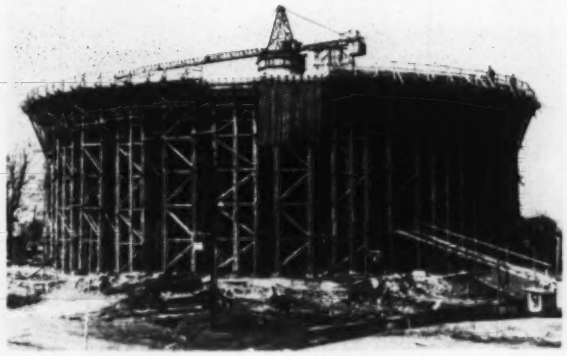
Finally, the cables were grouted. High-early-strength cement with 1 percent Intrusion Aid was used in the grout. The water-cement ratio was 0.34 to 0.37.

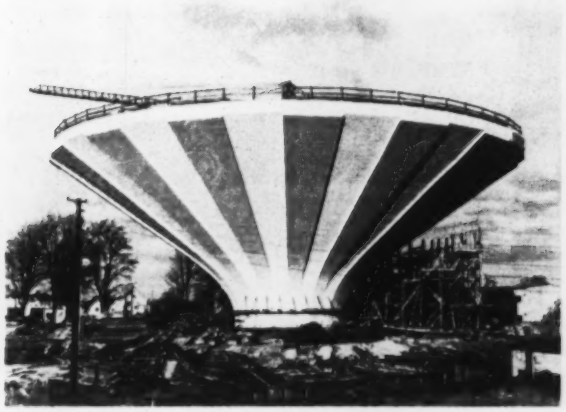
## Construction layout

Scaffolding for the reservoir was a major construction problem because of its height and shape. The outer reservoir wall with its foot-ring and the support for the inner wall were to be cast in one operation. The deformations of the scaffolding might have caused cracks in the conical wall. The contractor solved the problem in his own way. He avoided tall scaffolding and facilitated the placing of the concrete by constructing the reservoir at ground level. After it had been cast, prestressed, tested and painted, the reservoir was lifted to its ultimate position some 35 m (115 ft) above the ground by means of hydraulic jacks, the cylindrical stem being cast simultaneously with the lifting process.

Construction work started in July 1955 and was carried out in the following way. First the substructure was cast and the elevator cylinder was built with sliding forms to a height of 20 m (65 ft) above ground level. A swinging crane was fixed to the top of the elevator cylinder. The formwork and the prestressing cables were assembled during the autumn and winter. Bad weather conditions during the late autumn together with some unforeseen delays caused the casting of the reservoir to be postponed until the spring of 1956. After the reinforcement and the cables had been mounted, the reservoir concrete was placed in May 1956.

Low-heat portland cement was used in the reservoir partly to retard setting of the concrete, which was necessary because of the long perimeter of concrete that had to be kept fresh. This type of cement decreased the shrinkage due to





**By constructing the reservoir on the ground (above left) the contractor avoided tall scaffolding and facilitated placing of concrete. For the central elevator cylinder, sliding forms were used. Photograph above right shows the reservoir ready to be lifted by 32 hydraulic jacks, the supporting "stem" being cast simultaneously. Low-heat portland cement was used in the reservoir to retard hardening of concrete. This also lessened shrinkage due to temperature changes during curing period and decreased danger of cracks developing in the hardening concrete caused by settlement of scaffolding.**

temperature changes during the curing period and it also resulted in a decrease in the risk of cracks in the hardening concrete, caused by settlement of scaffolding.

The conical wall was cast without an overform. This turned out very well, and concrete with a slump of as much as 8 cm (3 in.) could have been used. In the zone of double curvature, an overform was used.

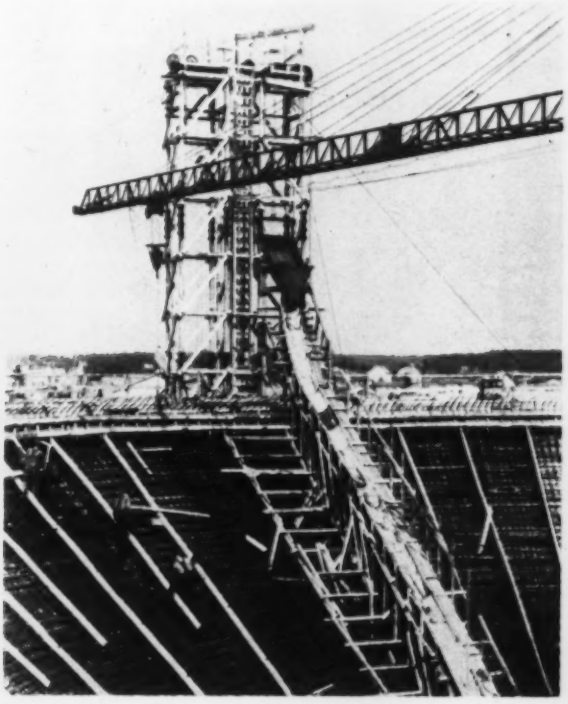
From the batcher to the upper edge of the reservoir, the concrete was transported by an elevator, then tipped into a hopper and passed down a chute to a bucket on the casting level. The crane handled the bucket to the dumping points. Immediately after the concrete had been placed and vibrated, the surface was trowel finished.

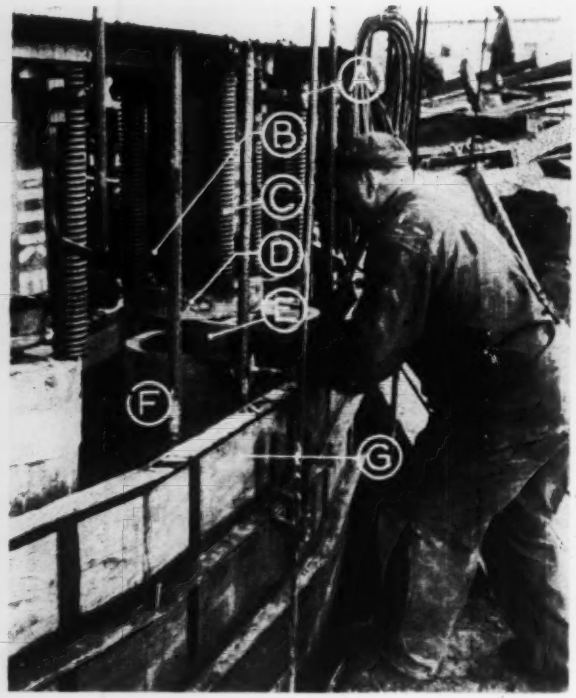
The first stage of prestressing was executed two weeks after casting and the second stage after another three weeks. The inner wall of the reservoir was cast in one operation, simultaneously with the first stage of prestressing. The reservoir was then filled with water to test its watertightness. After some minor repair work was completed, the outside was painted and the reservoir was ready to be lifted.

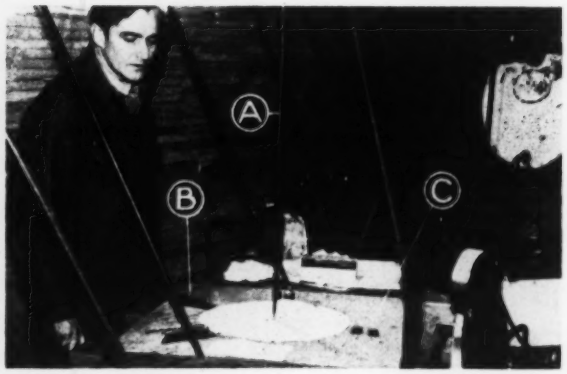
Concrete in the staircase and the upper part of the elevator cylinder was

**Concrete was transported from batcher to upper edge of reservoir by elevator, then tipped into a hopper and passed down a chute to a bucket at placing level.** →

**Inclination of inner reservoir wall, cast without overform, is 34 deg. Surface was trowel finished immediately after concrete had been placed and vibrated.**






**Above: During lifting operation, a check was kept on alignment, tilting, and rotation by use of a control board suspended from the reservoir. (A) is the pendulum; (B), levels; (C), signal lamps.**

**Left: A 4-in. aluminum block is being inserted in wall of "stem" after a jack has been relieved from oil pressure and piston has been drawn back by return springs. (A) is discharge valve; (B), safety nut; (C), return springs; (D), pressure-distribution plate; (E), aluminum block; (F), 11-in. concrete block; and (G), outside movable forms.**

placed during the lifting work, which was completed in the beginning of February 1957. In the spring and summer the roof structure was built and the installation of pipes, elevators, electrical and sanitary equipment was started.

The water tower was put in operation in December 1957.

### Lifting operation

The lifting operation was the most conspicuous part of the work. The accompanying photographs show how the "mushroom" grew up from the ground. The weight of the structure to be lifted was 3,200 tons. Lifting was done by thirty-two hydraulic jacks which were fixed upside down at the lower edge of the reservoir. They were arranged according to the scheme shown in Fig. 4. The jacks had a nominal capacity of 100 tons at an oil pressure of 400 kg per sq cm (5,700 psi) and all were tested to 200 tons, primarily with regard to tightness. One jack was tested to 300 tons. Each jack was supplied with an inlet valve, a discharge valve, and a reflux valve which was combined with a pressure gage. The jacks had a stroke of 15 cm (6 in.), and were equipped with safety nuts which, after tightening, could carry the load if the oil pressure had to be relieved.

Careful studies and many discussions preceded the final adoption of a system for the lifting work. Accordingly (see Fig. 4), twenty-nine jacks were connected with a motor-driven pump (with another similar pump as a spare). The remaining pumps were located at the third points on the circumference and were supplied with oil from separate hand-driven pumps. Three jacks of the main system could be connected with the hand-driven pumps in case the excentricity of the load caused by wind and non-uniform placing of the concrete proved to be too great. The idea was to take the bulk of the load with the twenty-nine jacks, which were put under a pressure slightly lower than that at which lifting would have started. The remaining load was taken by the three hand-operated "governing" jacks. By controlling the rate of lifting at these three points, vertical lifting could be effected.

After a lift of about 12 cm (5 in.), one of the jacks was relieved from the oil pressure and the piston was drawn back by return springs. A 10-cm (4 in.) aluminum block was inserted, as shown in a photo. Then the discharge valve of the jack was closed and the inlet valve opened, putting the jack under pressure again. The same procedure was repeated for the other jacks, generally two at a time. After another lift, a new set of 10-cm (4 in.) blocks was put in. The third time the aluminum blocks were removed, concrete cylinders 29 cm (11 in.) high were inserted under the jacks. About 4,000 of these cylinders had been precast and stocked at the site.

After another lift, a new layer of 10-cm (4-in.) blocks was put in and concrete was placed between movable forms. Thus a ring of the cylindrical stem 29 cm (11 in.) high was placed and the concrete cylinder blocks were encased in the wall.

Bars for the vertical reinforcement were supplied through vertical pipes in the bottom of the reservoir.

The lifting operation was checked with regard to alignment, tilting, and rotation from a maneuver and control board suspended from the reservoir, as shown in a photograph. Among the control devices were a pendulum plummet, levels and control lamps which were lighted or extinguished as the water level in communicating vessels on the roof went up or down a certain distance from the neutral position.

No delays occurred during the lifting work. After some difficulties had been overcome, the lifting proceeded at a speed of 58 cm (23 in.) a day, that is, the height of two concrete blocks. The lifting operation required about three months.

Lifting was terminated in such a way that the reservoir can be raised further in the future if required. Thus the reservoir is freely supported by the stem cylinder, the vertical reinforcement of which is not anchored in the reservoir.

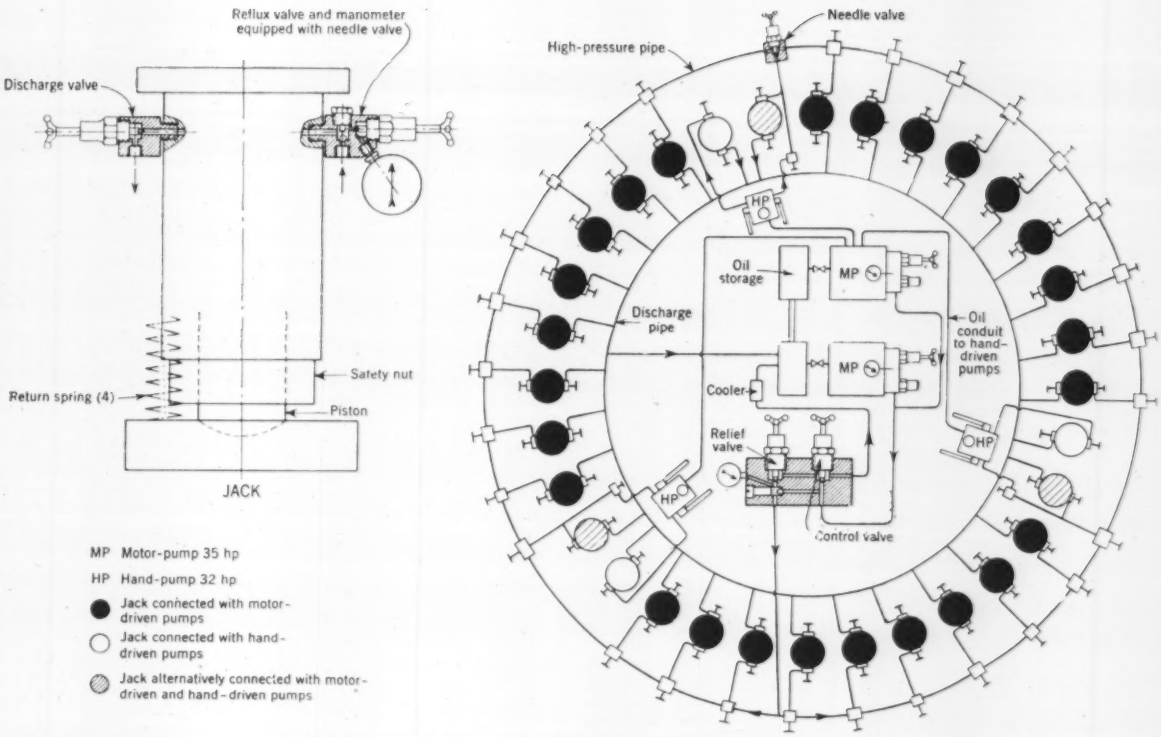



**FIG. 4. To raise the reservoir on its "stem," thirty-two hydraulic jacks were fixed upside down around its lower edge. The jacks, with a stroke of 6 in., were equipped with safety nuts which could carry the load if the oil pressure had to be relieved.**

Arrangements have been made so that recesses for the jacks can easily be provided.

### Construction costs

During the design stage, the city authorities declared themselves prepared to spend some extra money (say up to 10 percent) in order to get a proper architectural design. Surprisingly enough, the construction costs proved to be somewhat lower—in any case not higher—than was anticipated for a conventional tower of the same capacity and height, taking into consideration the special features provided, that is, the restaurant and the radio and television facilities.

The City Office for Public Works, Orebro, Sweden, is the purchaser of the water tower.

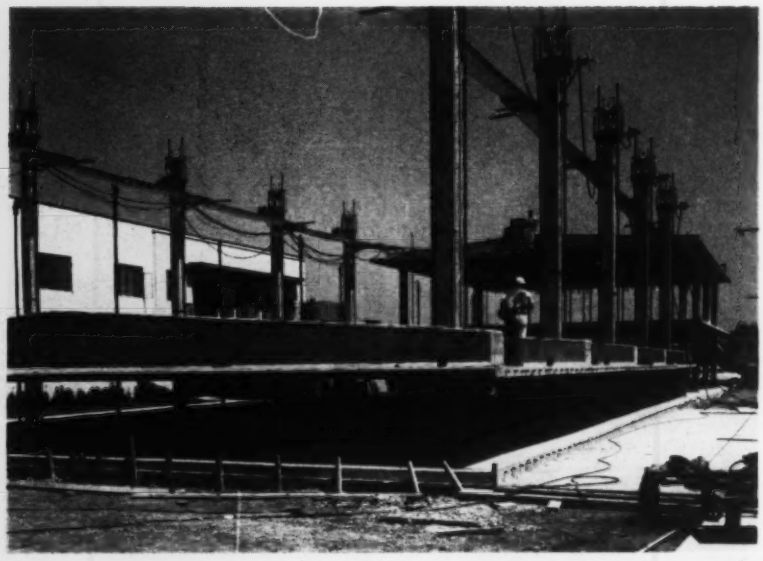
Consulting engineers and architects were A. B. Vattenbyggnadsbyran (VBB), Stockholm, with V. Jansa and I. Gullström responsible for the designing work, in collaboration with Prof. S. Lindström for the architectural layout, and with Prof. E. Reinius and the writer for the structural design, including the prestressing.

The contractor was A. B. Svenska Stenbelaggningar, Uppsala, with G. Stenfors as Chief Engineer and L. Gerdin as Resident Engineer.

Lifting equipment was supplied by A. B. Nike, Eskilstuna.

**Reservoir is on its way up. Hydraulic jacks and fresh concrete of the "stem" were housed, and space inside was heated as lifting operation was executed during winter.**

**T. Y. LIN, M.ASCE,**
Professor of Civil Engineering,
University of California,
Berkeley, Calif.



**Lifting operations are under way on U.S. Geological Survey Building, Menlo Park, Calif. Note inverted beams on top of roof with steel rods extending downward to hold up second-floor slab. Floor slab is 6 in. thick, with spans of 50 ft. Architects and engineers are Akol, Angell and Apaydin, Berkeley, Calif.**

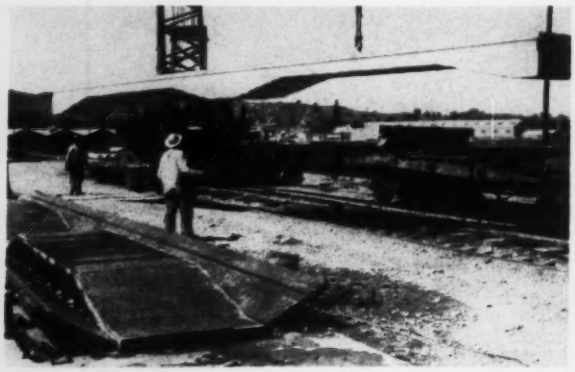
**Solid prestressed concrete slabs 6 in. thick are used in Vacaville Hospital building for Division of Architecture, State of California. Here roof and floor slabs have been lifted into position.**

Design and research in the United States on prestressed concrete slabs and shells have followed the economic and construction requirements peculiar to this country. Designs, to be economical, must take into account construction methods and facilities. Research work, to be of practical value, must be tied in with present or future applications. Thus it often happens that the necessary research work cannot catch up with design, and good design comes only after some pioneering construction.

In this country civil engineers, architects, and builders are beginning to sense the economy and desirability of prestressing concrete slabs and shells. Among the advantages of prestressing are control of deflections, elimination of cracks, reduction in dead weight, increase in strength, lengthening of spans, and versatility in shapes. Because of these inherent advantages, engineers have been designing economical and safe prestressed slabs and shells without an adequate theory for analysis. Approximate methods have been devised and applied with factors of safety guided by judgment. Not until many similar structures have been built can the design procedures be refined and modified—as a result of either experience or research.

When prestressing is extended from its beam applications to two-dimensional slabs and three-dimensional shells,

**Pretensioned pilot slab, 48 x 4 ft, for wharf construction in Kuwait, on the Persian Gulf, was made in Ben C. Gerwick's plant at Petaluma, Calif., for testing.**



**Prestressed slab 6 ft square and 6 in. thick is being tested for shearing strength at University of California laboratory.**

# PRESTRESSED CONCRETE—SLABS AND SHELLS

## Design and research in the United States

the theoretical problems involved cannot be handled by the usual methods available for structural analysis. For example, prestressing a continuous slab means applying an irregular pattern of horizontal and vertical forces much more complicated than the usual uniform gravity loads. Prestressing a curved shell imposes inclined components along the tendons, the effects of which cannot be expressed in simple algebraic form. Such properties of concrete as its strength, deformation, creep, and resistance to buckling, are not too well known when it is prestressed in two or three directions.

### Design approaches

Two major criteria are applied for the design of prestressed concrete slabs and shells—proper behavior under service conditions and sufficient strength to carry occasional overloads. The traditional method of using allowable stresses as the main criterion for design is no longer possible for these unconventional structures. Instead, the ultimate strength of the structure is important as the guide for design. The factor of safety is not constant for all structures, or even for all parts of the same structure, but varies with the accuracy of the designers' estimate of the ultimate strength, the possibility of overloads, the cost of increasing the safety factor, and other considerations.

Proper behavior under actual service conditions must be investigated for each structure. By proper behavior is meant the absence of excessive camber and deflection, the provision for creep and shrinkage, and the limitation of cracks and of vibrations. Again it is difficult to set a fixed standard applicable to all structures, but where the engineer is uncertain of the performance, he should err on the safe side. Increasing the prestressing force does not always mean better performance because excessive camber and creep may be the result.

There is a certain relation between the most desirable load on a prestressed structure and its ultimate load. Frequently the most desirable condition for a slab or shell is when it has neither deflection nor camber. This condition may be realized at dead load only, or at dead plus some live load. Then there should be sufficient load carrying capacity from that point up to the ultimate load. The design load should be chosen by considering the behavior of the structure, its ultimate strength, and overall economy.

An important new concept in the design of prestressed slabs and shells is the attempt to balance the major part of the gravity loads by prestressing. If this is properly done, analysis need only be made for the unbalanced loads, and the required accuracy is very much reduced. This approach often enables the designer to predict the behavior of a prestressed slab or shell better than a non-prestressed one, even though only an approximate design method is used.

For the relatively short spans of slabs and shells built in this country, stress as such is often not an important criterion for design. Usually stress will play its part only as it effects creep, deflection, and cracking, particularly in areas of high stress concentration. When spans get really long, it is then conceivable that compressive stress in concrete as well as buckling will control the design.

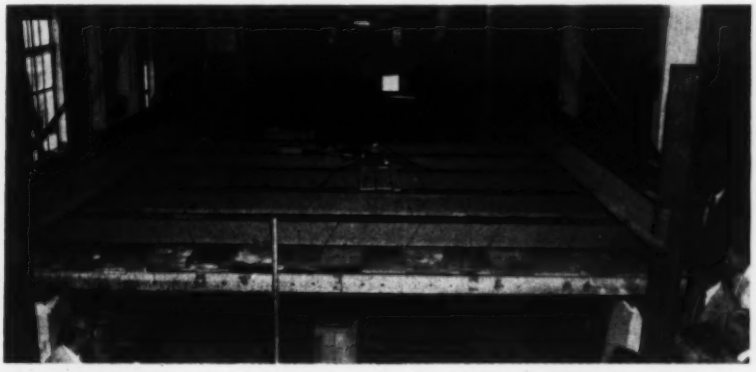
### Design of slabs

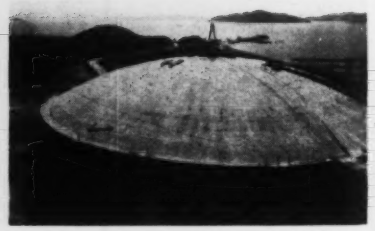
When prestressing was first applied to slabs in the United States, it was principally an attempt to produce crack-free floors for carrying heavy loads. While such structures have served their purpose quite well, they cannot always be justified economically. When these slabs were post-tensioned in place, complications arose because they tended to shorten under the prestress. Unless the slab is properly separated from its supporting columns and walls, such shortening will move the supports with the slab, sever the connections between them, or dissipate the prestress into the supports—although these objections may or may not be serious.

Widespread adoption of prestressed slabs in this country came as a result of lift-slab construction.[1,2,3] The lift-slab method consists of casting the floor and roof slabs on the ground, with one directly on top of another, and then lifting them into position by means of jacks mounted on top of the supporting columns. Lift-slabs were first built of conventional reinforced concrete. But it was soon found that these slabs, especially of longer spans, deflected too much and cracked noticeably upon lifting.

By prestressing curved cables in these slabs, it is possible to balance the force of gravity and produce thinner slabs which have no cracks and remain practically flat upon lifting. A thinner slab is easier to lift, and may result in fewer columns, longer spans, and simpler lifting operations. The lifting pro-

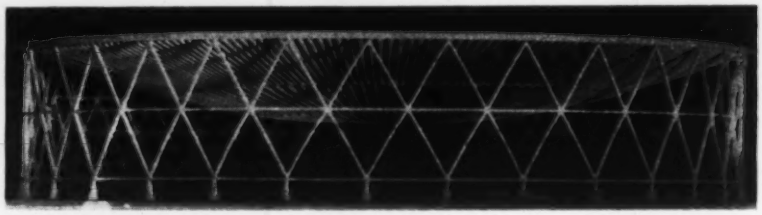
**Uniform load is applied by plastic air bags to prestressed slab 15 ft square and 5 in. thick, supported at four corners, at University of California.**





**Prestressed concrete dome of 200-ft diameter covers reservoir of East Bay Municipal Utility Dist., Richmond, Calif.**

**Proposal for an exposition center has inverted dome of 400-ft diameter, of precast prestressed concrete. Designer is Myron Goldsmith, of architectural firm of Skidmore, Owings, and Merrill. T. Y. Lin was special consultant on the design.**



cedure enables the shrinkage and shortening of the slabs to take place before they are connected to the columns and walls, thus largely eliminating this problem, encountered when cast-in-place slabs are post-tensioned.

In the United States a highly developed ready-mix industry simplifies the field concreting operations, and where contractors with lifting equipment are available, there is no question but that prestressed lift-slab construction will continue to grow. Furthermore, general building contractors like lift-slab construction when they find out that the work for the trades is also simplified.

Many variations of the solid flat slab have been used. The solid slab has been found economical for spans of from 20 to 35 ft, with slab thicknesses between 5 and 10 in. For greater spans, the weight of a solid slab becomes objectionable, therefore waffle and joist slabs are often economical. Prestressed beams have also been designed underneath the floor slab, in which case, ditches for the beams must be excavated in the ground. They can also be added above the roof slab to form inverted beams, permitting spans of 50 to 100 ft.

When longer spans are desired for the ground floor, it is economical to hang the floor slabs to the inverted prestressed beams of the roof, by means of steel rods. Since the inverted beams can have a greater structural depth, the cost of carrying the additional loads is not excessive, while the number of columns and footings can be correspondingly reduced.

Roof slabs prestressed in two directions are watertight and thus require no roofing material. In a factory building with bays 66 by 60 ft, the cast-in-place roof slab was prestressed in two directions and has been carrying 2 in. of water for two years.[4]

Pretensioned slabs with voids cast in them are produced in a Spancrete factory in Milwaukee, Wis. They are generally applicable to spans of 10 to 20 ft. Production of hollow slabs for spans up to 100 ft is under study by the Material Service Corp. of Chicago.

Solid slabs precast in a factory are not extensively used in the United States. The State of California has designed and built pretensioned solid slabs for continuous spans. Continuity reduces the number of connections and the number of pieces to be handled. They have been found economical when the size and weight of the slab is within the capacity of the available placing equipment.

Precast pretensioned slabs continuous over two spans of 13 ft each were incorporated in the 1,050-ft-long Switzer Creek storm drain in San Diego, Calif.[5] These carry 2 to 4 ft of earth fill plus railway E-60 loadings. A novel idea involved was the haunching of the slabs over the center pier support, thus enabling straight pretensioned strands to carry both the positive and the negative bending moments. This same idea was further utilized in a $23,000,000 wharf constructed in Kuwait, undertaken by the J. H. Pomerory Co. of San Francisco. The first pilot slab was made in Petaluma, Calif. These slabs were cast 48 ft long apiece, so as to act continuously across two spans of 24 ft each. Their ends are staggered so that when post-tensioned transversely, they form a continuous wharf, 70 ft wide and 600 ft long.

Research on concrete slabs in the United States has followed the requirements of design and is therefore centered on the behavior of lift slabs. Two projects will be briefly summarized.

**Shearing strength of prestressed concrete slabs.** A series of shear tests on 12 slab specimens 6 ft square and of varying thickness were performed at the University of California[6] to determine their shearing strength, taking into account the following variables: concrete strength, magnitude of prestress, size of steel collars, thickness of slab and effect of recess.

On the basis of these tests, the following conclusions were drawn:

1. Application of the 1956 ACI Code method for calculating the allowable shear load on reinforced slabs, to the test specimen of a prestressed slab, yielded a wide range of factors of safety based on the ultimate strength—from 3.3 to 5.3.

2. The actual ultimate punching shear stress at the edge of the steel collar as computed by the usual formula, $v = V/bjd$, varied from 0.12 $f'_c$ to 0.21 $f'_c$ for the slabs tested.

3. The ultimate shearing stress at the edge of the collar can be predicted by the following empirical expression within an accuracy of about 10 percent for the slabs tested:

$$v = 333 + \frac{0.046\ f'_c}{\phi_0}$$

where $\phi_0$ is the ratio of the ultimate shear capacity to the ultimate flexure capacity and varies from 0.65 to 1.14 for the slabs tested.

These tests brought out the interaction between moment and shear on the ultimate shear capacity of prestressed slabs, as was recently shown for reinforced slabs. In the absence of a rational solution, these tests provide a basis for the design of slabs within the range of the test specimens.

**Square slab supported on four corners.** A slab 15 ft square and 5 in. thick prestressed in two directions, was supported at the four corners only, simulating a simply supported lift slab.[7] It was loaded uniformly by means of air pressure applied in plastic bags. The purpose was to determine the elastic behavior and the ultimate strength of such a slab and compare results with those obtained by applying elastic and ultimate-load theories.

The slab was concentrically prestressed to a value of 418 psi in both directions. If no tensile stress is permitted in the concrete, the elastic-plate theory shows that this slab can barely carry its own dead load of 63 psf, and has no live-load capacity at all. The actual test, however, showed excellent behavior of the slab up to at least a live load of 80 psf, with a maximum tensile stress of 500 psi. The first crack was observed at a live load of 104 psf, and the ultimate live load was 238 psf.

The recorded strains and deflections showed close agreement with the classi-

**Hyperbolic paraboloid concrete shell is prestressed uniformly in two directions, for a church, in Tustin, Calif. The structural engineer is F. Weaver of Los Angeles, Calif.**

**Grandstand roof for National Racecourse, Caracas, Venezuela, has prestressed shell 3 in. thick, cantilevered 90 ft. Architect is Arthur Froehlich; structural engineer, Henry M. Layne.**

**Hyperbolic paraboloid shell 15 ft square and 1 in. thick, of umbrella shape, was tested at the University of California laboratory. It carried 245 psf of sand at failure.**

cal elastic theory up to the point of cracking. The ultimate load also agreed with the crackline theory as applied to prestressed slabs.

It is evident from these tests that the old concept of allowing no tension in prestressed concrete cannot be applied to slabs. These tests indicate that the only proper way to design a prestressed slab is to base the design on the behavior and ultimate strength of the slab. The use of a fixed value for allowable tensile stress should be discarded.

The first prestressed concrete shells built in the United States were the dome roofs for cylindrical water tanks. Their construction probably started in the 1930's, and the largest one to date is the Richmond Reservoir with a diameter of 200 ft. These domes are prestressed only along their edge beams, the amount of prestressing being determined by a semi-empirical approach. Generally sufficient prestress is applied to the edge beams to barely lift the dome off its falsework, this being the amount computed to counteract the hoop tension produced by dead load plus some live load.

It is seen from the above that prestressing the shells often greatly reduces the edge disturbances by limiting the usual deformation along discontinuous edges. This is very desirable, since edge disturbance can be a serious problem in shells. By balancing the gravity loads, controlling deflections, and eliminating cracks, the prestressing of shells permits thinner sections and longer spans. Prestressing is certainly not limited to shells of the dome type.

In a reinforced concrete shell, the reinforcement acts only when the concrete cracks. In a prestressed shell, the steel takes the desired load from the beginning. Because of the high available structural depth in a curved surface, the amount of prestress required is much lower than in a slab-and-beam type of design. These factors tend to increase the economy of prestressed shells.

One major deterrent to the use of shell construction in the United States is the cost of formwork and falsework. This is being overcome by precasting, or by using movable formwork.

Precasting for shells opens up an entirely new field of design for engineers. A photo shows a 400-ft inverted dome proposed by the architects, Skidmore, Owings, and Merrill, with all elements precast and prestressed. Prestressing is also an excellent means of joining the elements together. Another advantage of precasting is the reuse of forms, and the design should be made with that in mind.

Shells of unusual form also lend themselves to prestressing. A hyperbolic-paraboloid roof supported at three points was built for a church in Tustin, Calif. For convenience in construction, this was uniformly prestressed in two directions sufficiently to eliminate all tensile stresses. If the span had been longer, it would have been desirable to apply prestress only along the lines of tension.

The shell roof for the grandstand of the National Racecourse in Caracas, Venezuela,[8] is cantilevered 90 ft and has a 3-in. thickness. Cables in the edge beams were prestressed to balance the dead loads, thus putting the entire shell under direct compression—transforming a cantilever into a horizontal column. These cantilevers were designed to camber 1 in. immediately after prestressing so that, in the course of years, it would come down flat. The catenary shells were prestressed in the curved direction to eliminate any cracks.

### Research on shells

Very little research on prestressed-concrete thin shells has been carried out in the United States, the main reason being that not many have been designed and built. So far as the writer knows, only one major test has been executed. A hyperbolic-paraboloid shell of the umbrella type was tested at the University of California. It was 15 ft square in plan, 1 in. thick, and supported at the center only.[9]

The four edge beams of the shell were 3 in x 3½ in. in section and prestressed with two ¼-in. wires. The shell carried an ultimate live load of 245 psf. At failure numerous cracks had developed.

This simple test demonstrated the excellent behavior of prestressed thin shells and their inherent strength. The amount of prestressing steel required for this shell was very small, only 0.09 lb of steel per square foot of area.

The writer wishes to acknowledge the effort of E. K. Rice, J.M.ASCE, and F. Kulka, A.M.ASCE, of T. Y. Lin and Associates, Los Angeles, who took part in the special consultation for the lift slabs shown in this article, the wharf in Kuwait, and the grandstand for the National Racecourse in Caracas.

*(This article is based on a paper to be presented by Professor Lin at the ASCE Annual Convention in New York, before the joint session on "Prestressed Concrete Bridges," of the Construction, Engineering Mechanics, and Structural Divisions with the International Association of Bridge and Structural Engineering (IABSE), presided over by Dan H. Pletta, a member of the Engineering Mechanics Division's Executive Committee.)*

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4 "Continuous Prestressing Makes Concrete Roof with 66-ft 8-in. by 60-ft Bays Economical," *Southwest Builder and Contractor*, March 22, 1957.

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6 "Shearing Strength of Reinforced Concrete Prestressed Concrete Lift Slabs," T. Y. Lin, A. C. Scordelis, and H. R. May, Oct. 1957, State of Calif., Documents Sect., Sacramento, Calif.

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8 "Roofs Are Top Attractions at New Race Track in Caracas," T. Y. Lin, *Eng. News-Record*, April 24, 1958.

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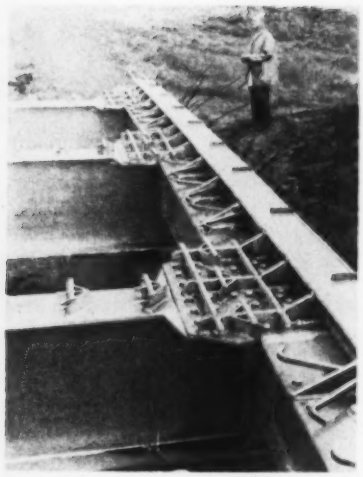
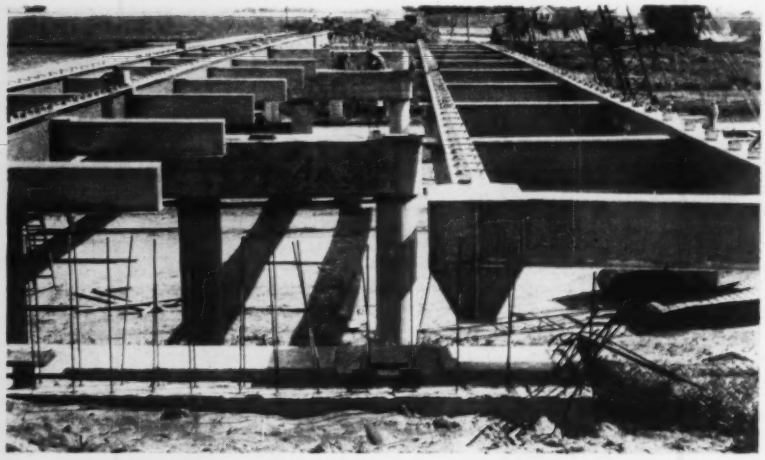
Continuous welded aluminum girder, of four spans totaling 220 ft, is now in use over new Interstate Highway in Des Moines, Iowa.

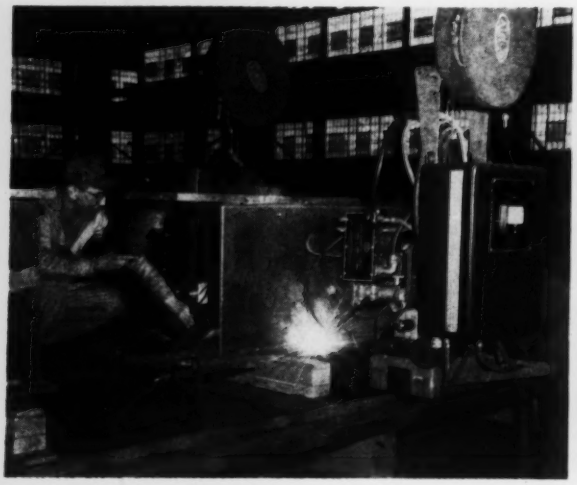


End expansion dam is all aluminum, bolted to end diaphragms. Note detail of shear lugs.

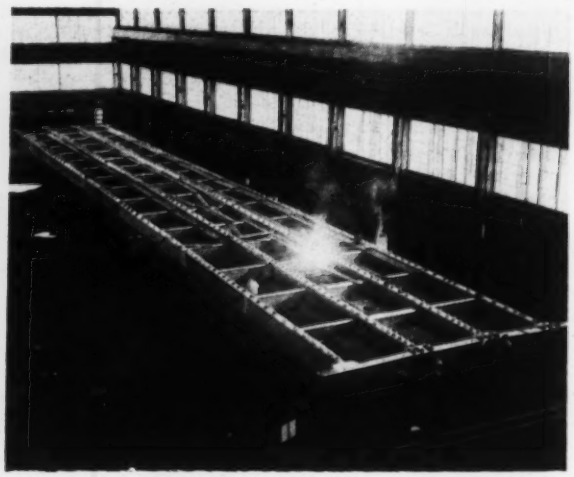


Center diaphragm is in place on first pair of girders as small cranes move 125-ft aluminum section into position on piers.

Twin-head Aircomatic welder lays 5/16-in. fillet on each side of vertical plate in one pass, at rate of 20 in. per min.



Aluminum frame 221 ft long was fabricated and assembled at Pullman Standard Car Manufacturing Co. plant in Chicago.



# First welded aluminum girder bridge spans Interstate Highway in Iowa

**NED L. ASHTON, M.ASCE,** Consulting Engineer, Iowa City, Iowa

The world's first welded aluminum girder highway bridge is now in service in Des Moines, Iowa, on a new Interstate Highway. The site was selected because in length and other characteristics it is typical of many grade-separation sites throughout the country.

Four continuous spans—41.25 ft, 68.75 ft, 68.75 ft. and 41.25 ft—total 220 ft to carry a local road over the Interstate Highway. Four lines of girders, spaced 9.5 ft on centers, support the 8-in. composite concrete deck. Structural members were fabricated entirely from flat-plate, non-heat-treatable structural aluminum alloys, assembled by welding. High-strength aluminum bolts were used for field erection. Only 76,850 lb of material was required, including 3,734 lb in the expansion dams at the end of the bridge—10.6 lb per sq ft of bridge on the basis of the roadway plus one sidewalk as equivalent area.

The roadway surface is 30 ft wide between curbs, but the total width is 36 ft, including the refuge sidewalks on cantilevered curbs. See Fig. 1. The sidewalks, protected by aluminum handrails, have a clear width of 2 ft.

The bridge is made of aluminum because it is experimentally economical. The modern magnesium aluminum alloys are as strong as steel and much easier to handle. Aluminum will last a lifetime without maintenance or painting as it does not rust or corrode in the atmosphere as ferrous metals do.

The bridge is welded since welding is by far the best modern method of joining metals. The new combination of magnesium and aluminum is easily weldable without special treatment.

This bridge was designed by the writer and fabricated by the Pullman-Standard Car Manufacturing Company of Chicago. It was erected by the Jensen Construction Company–United Contractors of Des Moines for the Iowa Highway Commission at a cost of $124,682. This pioneering aluminum structure is sponsored by the three largest producers of the metal—Aluminum Company of America, Kaiser Aluminum and Chemical Corporation, and Reynolds Metals Company—pooling their efforts with the Iowa State Highway Commission. Each has agreed to contribute $10,000 for research as a development contribution so that the actual cost to the State of Iowa was no more than the first cost of a comparable steel bridge, since the funds are being used for research in lieu of other funds that would have been appropriated for this purpose.

There is also an initial penalty in cost which results from having only flat

### Tips on aluminum welding

Tack welds should be chipped out ahead of the automatic welder.

Surface of the metal should be thoroughly cleaned and freed of scale, preferably by disking.

Tabs should be provided beyond the end of the permanent work for starting and terminating all weld beads; the operation will thus be proceeding at normal speed for the full length of the required weld.

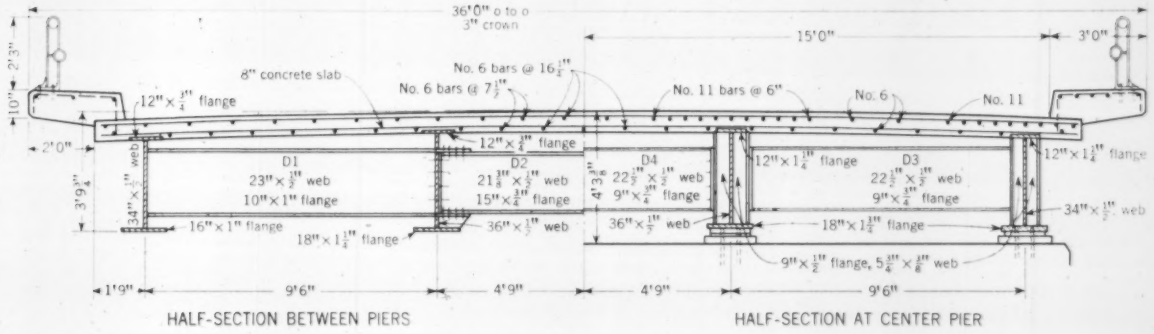
It is important that the current, electrode and weld head size be proportional to the size of the part. This permits time at the termination of a weld to reverse direction to eliminate crater formation.

Air jets are quite effective in controlling the thermal gradient so as to prevent warping of web plates.

For hand welding it is advantageous to have all electrical, water cooling and gas shielding conduits in the same bundle leading to the handle of the welding gun.

All welders should pass rigid qualifying tests before being permitted to weld on the permanent structure.

**FIG. 1. Girders built up by welding of flat aluminum plate carry continuous four-span bridge. Spans are 41.25 ft, 68.75 ft, 68.75 ft and 41.25 ft. Aluminum lugs welded to the top plate bring a 96-in. width of the 8-in. concrete slab into composite action.**



plates and angles to work with for this pioneering structure. The cost would be considerably lower if the large beams could have been made in quantity by the extrusion process. This compares with the advantage that deep rolled-beam sections now lend to fabricated steel structures. In addition the extrusion process would improve the properties of the aluminum sections far beyond the possibilities of the rolled-steel sections.

The design follows the AASHO H20-SI6 live loading, assuming fully continuous composite behavior between the concrete slab and the aluminum beams in both positive and negative areas. Longitudinal steel reinforcing acts in combination with the aluminum beams in the negative areas over the piers.

Provision is made in the design for thermal stress from a 100-deg differential between the concrete deck and the aluminum girders. Strong connections are provided between the expansion dams and the girders at each end of the bridge.

Calculated stresses in the positive-moment area of the interior girder in the end span are, in psi:

| | Bottom Flange | Top Flange | Concrete |
|---|---|---|---|
| Dead load | + 1,520 | −1,760 | ..... |
| Live load & impact | + 7,440 | — 150 | −456 |
| For gravity loads | + 8,960 | −1,910 | −456 |
| −100-deg temp | + 5,560 | ..... | −340 |
| + 50-deg temp | ..... | −2,780 | ..... |
| Gravity + thermal | +14,520 | −4,690 | −796 |

These stresses are based on the assumption that the aluminum girder section carries the entire dead load without any composite action and that there will be full composite action for live load.

These assumptions are believed to be in full agreement with the real behavior of all deck beam-and-girder bridges and with very widely accepted modern design practice. The girders at this section consist of a 12 × ¾-in. top flange, a 12 × 1-in. bottom flange, and a 36 × ½-in. web plate. The 96-in. width of the 8-in. concrete slab is counted as the composite top flange.

The thermal stresses given apply to the contact flange and concrete surfaces only. Other more remote portions of the girder sections will have thermal stresses of lower intensity because of relief by bending action from the eccentric application of the concrete force.

In the negative area over the first piers, the inside girder section consists of a 12 × 1-in. top flange, a 36 × ½-in. web, an 18 × 1¼-in. bottom flange, and eleven No. 9 longitudinal steel reinforcing bars in the top of the concrete slab for composite action. Over the center pier an 18 × 1¾-in. bottom flange is used with No. 11 bars.

Substantial shear lugs are provided to insure composite action throughout the full length of the bridge. These lugs are made from angles and bars welded together and then welded to the girder with sufficient strength to develop 35,000 lb of shearing stress between the concrete and the aluminum at each shear lug.

Electrolytic action is prevented on all contact surfaces between the concrete and the aluminum by giving the embedded part of the aluminum members two coats of zinc chromate paint of wash primer and primer quality, meeting U. S. Military Specifications. In addition, the contact surfaces of the top flanges and end dams are given a heavy coating of alkali-resistant bituminous paint in accordance with ASCE specifications.

### Weldable aluminum

The metal used conforms to 5083-HII3 non-heat-treatable magnesium aluminum alloy meeting ASTM specifications B209-55T GM51A or Military (Ships) specifications A-19005. The welding wire used conforms to 5183 non-heat-treatable magnesium aluminum alloy. The shielded inert-gas metal arc-welding process was used for all welding. A consumable-electrode process was employed with a mixture of 75 percent helium and 25 percent argon as the shielding gas, at a flow rate of about 120 cu ft per hour.

The twin-arc Aircomatic set-up for attaching the flanges to the webs of the girders and diaphragms is shown in a photograph. This machine makes a 5/16-in. fillet weld on each side of the web at a rate of about 20 in. per minute. The hand welding was done by a similar process with Linde, Airco and Hobart equipment.

Welding totals for the job included 31,964 cu ft of gas; 1,297 lb 2 oz of 1/16-in. welding wire; and 12,473½ ft of welds.

The light weight of the aluminum alloy permitted field handling of the entire bridge in only four sections. Thus economical shop welding could be used to assemble the two girders with the diaphragms for each half of the roadway in units 125 ft 9 in. and 95 ft 3 in. long.

The transverse diaphragms are arranged as fully continuous transverse beams with flange plates extending through the webs of the interior girders. These are spliced to the flanges of the center diaphragm sections in the field, utilizing bolted connections.

It was practical to manufacture the three-span continuous diaphragms in a complete assembly using temporary pieces of web plates between the ends of the beams while the splices were being reamed. In this manner all the work of making the diaphragms was completed before they were assembled with the main girders. Thus, the diaphragms were ready made for holding the main girders in assembly while the sections of the diaphragm between pairs of girders were being permanently welded to the webs. The slot where the diaphragm flange plates pass through the girder web was welded on both sides as the last operation.

One splice in each of the four main girders and insertion of a central section in each diaphragm is all the field assembly required. A short section and a long section are placed side by side to stagger the splices in the main members. The main sections were transferred from railway cars to a trailer truck for hauling two miles down the right-of-way to the bridge site.

The larger prefabricated sections 125 ft 9 in. long, 11 ft 11 in. wide and 3 ft 6 in. deep weighed only 19,400 lb and were quite easy to haul and handle. It required only one and a half days to erect the entire bridge. The last car of material arrived on Saturday, July 12, and erection began on Monday, July 14. The reassembly was completed by Tuesday noon on July 15. All permanent bolts were in place complete by the end of the week, and the construction of form work for the decking began on Monday, July 21. All forms for concrete were supported from the structure.

A research program has been set up to record and study changes in the new structure. Levels and deflections were taken for each increment of dead load. Strain gages recorded the actual stress changes in the members as the concrete deck was added. Dynamic strain gaging and other observations are being undertaken to gain the maximum benefit from the project.

The aluminum bridge project was initiated by the Iowa State Highway Commission under the sponsorship of Commissioner Russel Lundy and Chief Engineer John Butter. Later it was adopted as a Research Project by the Commission's Research Board under the supervision of Director Mark B. Morris, A.M.ASCE, and Bridge Engineer Neil Welden, A.M.ASCE. The preparation of the design and detail plans of the bridge, inspection of the fabrication work in the Pullman Standard Car Manufacturing Co. shop and occasional inspections of the bridge during erection and concrete placing were handled by the writer. A great deal of technical assistance was given freely throughout the entire project by the Aluminum Company of America, Kaiser Aluminum and Chemical Corporation, and Reynolds Metals Company as co-sponsors of the project.

# Formulas for deflections of cantilever beam with variable section

**THOMAS D. Y. FOK, A.M. ASCE**

Design Engineer, Richardson, Gordon, & Associates, Pittsburgh, Pa.

In determining the camber of a built-up steel girder which spans two supporting columns and overhangs at both ends, such as a pier girder supporting a highway bridge deck, the deflections of the girder are first computed. When the cover plates are used for the center span but are extended only partly over the cantilevered ends, the deflections of the overhangs can be computed by superposition of the following:

1. The deflections due to change of slope at the support only
2. The deflections of a cantilever beam fixed at the support as shown in Fig. 1

Both steps can easily be carried out by one of the well known methods of computing deflections. When the applied loads are randomly placed with respect to the cutoffs of the cover plates, or when the load is uniformly distributed as in the case of dead load, Step 2 involves lengthy numerical computations which can best be carried out by the formulas derived for this purpose. See the two cases for this step as described at right.

With reference to the beam shown in Fig. 1, the notations are defined as indicated in the figure, unless otherwise noted.

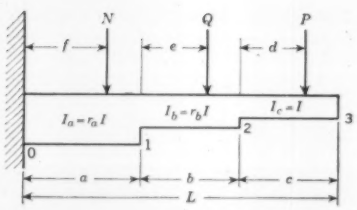



FIG. 1.

**Cantilever beam of variable section.**

**Case A. Concentrated loads *P*, *Q* and *N* acting as shown in Fig. 1**

$$\delta_1 = \frac{1}{6EIr_a}\left[Nf^2\,(3a - f) + Qa^2\,(2a + 3e) + Pa^2\,(2a + 3b + 3d)\right]$$

$$\delta_2 = \frac{1}{6EIr_a}\left\{Nf^2\,(3a + 3b - f) + Q\left[a^2\,(2a + 3e) + 3ab\,(a + 2e)\right]\right.$$
$$\left. + P\left[a^2\,(2a + 3b + 3d) + 3ab\,(a + 2b + 2d)\right]\right\}$$
$$+ \frac{1}{6EIr_b}\left[Qe^2\,(3b - e) + Pb^2\,(2b + 3d)\right]$$

$$\delta_3 = \frac{1}{6EIr_a}\left\{Nf^2\,(3a + 3b + 3c - f) + Q\left[a^2\,(2a + 3e) + 3a\,(b + c)\,(a + 2e)\right]\right.$$
$$\left. + P\left[a^2\,(2a + 3b + 3d) + 3a\,(b + c)\,(a + 2b + 2d)\right]\right\}$$
$$+ \frac{1}{6EIr_b}\left\{Qe^2\,(3b + 3c - e) + P\left[b^2\,(2b + 3d) + 3bc\,(b + 2d)\right]\right\}$$
$$+ \frac{1}{6EI}\left[Pd^2\,(3c - d)\right]$$

**Case B. Uniformly distributed load *w* throughout the beam, that is, $W_a = wa$, $W_b = wb$, and $W_c = wc$**

$$\delta_1 = \frac{W_a}{24EIr_a}\left[3a^3 + 8a^2\,(b + c) + 6a\,(b + c)^2\right]$$

$$\delta_2 = \frac{W_a}{24EIr_a}\left[a^2\,(3a + 4b) + 4a\,(b + c)\,(2a + 3b) + 6(b + c)^2\,(a + 2b)\right]$$
$$+ \frac{W_b}{24EIr_b}\,(3b^3 + 8b^2c + 6bc^2)$$

$$\delta_3 = \frac{W_a}{24EIr_a}\left[a^2\,(3a + 4b + 4c) + 4a\,(b + c)\,(2a + 3b + 3c) + 6\,(b + c)^2\,(a + 2b + 3c)\right]$$
$$+ \frac{W_b}{24EIr_b}\left[b^2\,(3b + 4c) + 4bc\,(2b + 3c) + 6c^2\,(b + 2c)\right]$$
$$+ \frac{W_c\,c^3}{8EI}$$

If there is only one change in cross-section of the beam, the same formulas can still be applied by considering $a = 0$, $f = 0$, and $N = 0$ for Case A, and simply $a = 0$ for Case B.

By using a digital computer, these formulas can readily be programmed for repeated use. The units in the formulas are self explanatory except that all lengths should be converted from feet to inches in order to obtain the deflections in inches. As an example, consider a beam with $a = b = c = 2.5$ ft, and $L = 7.5$ ft. $I = I_c = 3{,}960$ in.$^4$; $I_b = 5{,}940$ in.$^4$; and $I_a = 7{,}920$ in.$^4$. Hence, $r_a = 2.0$ and $r_b = 1.5$. $E = 30 \times 10^3$ kips per sq in.

**Case A. Concentrated loads**

Let $P = 100^{\text{kips}}$ at $d = 2.5$ ft; $Q = 100^{\text{kips}}$ at $e = 1.25$ ft, and $N = 0$ with $f = 0$. Then $\delta_1 = 0.0226$ in., $\delta_2 = 0.0786$ in. and $\delta_3 = 0.1535$ in.

**Case B. Uniform load**

Let $w = 5^{\text{kips}}$ per ft. Hence $W_a = W_b = W_c = 12.5^{\text{kips}}$. Then $\delta_1 = 0.00263$ in., $\delta_2 = 0.00847$ in. and $\delta_3 = 0.01603$ in.

# Reinforced concrete used for lightweight stretch forms

**ERNEST L. BUCKLEY, A.M. ASCE**

**Senior Design Engineer, Ground Support Group, Convair-Fort Worth, Division of General Dynamics Corporation, Fort Worth, Tex.**

The stretch-forming process is in common use in the aircraft industry in the production of sheetmetal parts and components. Sheets of aluminum alloy are drawn over a cast die normally made of some soft metal such as Kirksite, a zinc alloy. Modern aircraft design and production methods have come to require ever greater precision for cold-drawn parts of large dimension made of brittle, high-strength alloys. Cast dies, at the same time, have become larger, heavier and more difficult to handle. The handling problem is further aggravated, from the standpoint of cost, since it is frequently necessary to transport a prepared die tool a considerable distance for use on a subcontractor's press.

For economy, and to facilitate in-plant handling of large tools, an investigation of alternate die casting materials was initiated by Convair-Fort Worth. Noteworthy success was achieved through the casting of a large stretch-form block of reinforced concrete faced with cast epoxy-resin tooling plastic.

**Completed stretch-form die, at left, is covered with plastic facing. At right, Robert Thompson, in charge of test program, indicates line of failure of aircraft skin part stretched to destruction to test reinforced-concrete die.**

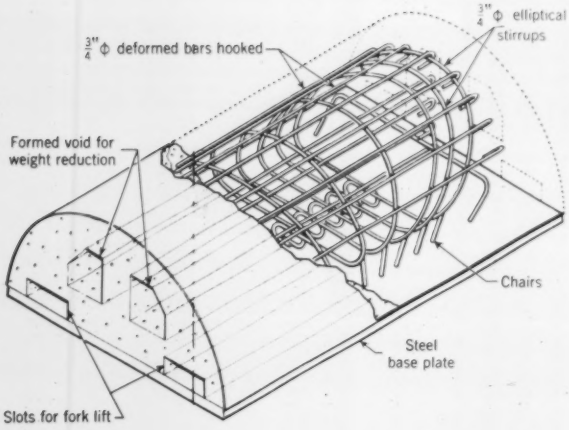



**FIG. 1. Concrete stretch form has reinforcement welded in place on steel base-plate.**

Preliminary study indicated that the use of reinforced portland cement concrete would be feasible. An aircraft outer-skin part was selected that would require a stretch-form die of simple half-cylindrical configuration. The part was to be drawn from a blank, 8 ft by 10 ft, of 70-75T6 aluminum alloy, 0.125 in. thick.

The base-plate structure of the stretcher-form die was designed to accommodate the configuration of the hydraulic-press bed and to permit the handling of the completed tool by fork-lift truck. The reinforcing steel, fabricated as shown in Fig. 1, was welded in plate on the steel base-plate.

A mold was made, in the conventional manner, of tooling plaster. The inside of the form was lined with Fiberglas cloth so that the tooling surface of the completed concrete die would have a uniform texture, the better to bond with the epoxy resin facing that would be applied. The base structure, with reinforcing steel attached, was set into the plaster mold. Two wooden inserts were placed to create voids near the center of the cross section of the die, thus further reducing the weight. Set on end and securely bound, the assembly was ready for concrete.

Ready-mix concrete was used with a design ultimate compressive strength of 4,500 psi at 28 days. Maximum aggregate size was ½ in. Concrete was placed using pneumatic vibrators inside the forms. After being covered with fabric and kept wet down for seven days, the forms were removed. The plastic surface was cast over the concrete tooling surface using Epocast 4D, manufactured by the Furane Plastic Company of Los Angeles. This facing provided the necessary smoothness and eliminated the possibility of abrasion of the part during forming.

The completed tool was placed in the stretch-form press and two skins were formed. To test the tool, the first skin was stretched to destruction. Neither the concrete nor the plastic facing showed signs of distress. A second skin was formed at 1000 psi below the ultimate stress of the aluminum alloy, and upon inspection was found acceptable.

Advantages of the concrete stretcher-form block are:

1. Its weight is less than one-third that of a comparable tool of Kirksite.
2. Its direct cost is about half that of

a Kirksite tool. This is true even taking into account a salvage value of 98 percent for the Kirksite. The capital investment is negligible as compared to that for a Kirksite tool of comparable size.

3. If the prepared die must be transported several hundred miles for use, the savings in shipping costs are startling. There is first the economy gained in handling and shipping the lighter tool. Second, the concrete tool can be scrapped on the spot when it is no longer needed. The Kirksite tool would have to be shipped back to its point of origin for reclamation of the costly die-casting metal.

The test results clearly show that reinforced portland cement concrete can be used to advantage in many tooling applications in the aircraft industry. At Convair-Fort Worth this type of tooling will be used when short production runs are anticipated, when the completed stretcher-form block is to be shipped for use at another location, or whenever the use of Kirksite will result in a tool weight of over 20,000 lb. Substantial savings are anticipated.

Robert Thompson, Manufacturing Research Engineer of Convair-Fort Worth, was responsible for the development and execution of the test program described. The writer acted in a consulting capacity for the structural design and stress analysis.

# Improved type of grade-separated highway intersection

**ROBERT SCHUMACHER, M. ASCE,** Transit Authority, New York, N. Y.

For many years the cloverleaf pattern of intersection has been the very symbol of the modern express highway. In recent years, with the enthusiastic public acceptance of large expressway projects, highway designers have favored the very costly "directional-ramp" type of intersection to replace the cloverleaf. To an engineer whose background is in the field of subways (where the grade separation of traffic lanes was practiced long before it was applied to highways), a "crossover" type of intersection stands out as superior to either of the other two in the case of an intersection of two major highways.

In modern subway design there can be no crossing over of traffic at grade. Neither can there be any form of weaving on subways such as is required in the cloverleaf. Every modern subway track must be able to accommodate trains at maximum capacity without interference from maximum-capacity operation on any other track.

From the viewpoint of a subway engineer, the standard cloverleaf, as shown in Fig. 1, has three disadvantages:

1. Its large acreage is particularly objectionable where intersections are required in urban areas. Land purchase, condemnation, demolition, and loss of property from tax rolls make cloverleafs extremely costly.

2. Left-turn movements must be accomplished by a convolution of 270 deg to the right. Such a movement involves additional travel of as much as a quarter of a mile or more for each vehicle left-turn. This is an unnatural movement for drivers and also results in a considerable cost for additional vehicle-miles per year.

3. There are four places in every standard cloverleaf where the objective of permitting both through and turning traffic to move smoothly is not fully accomplished. All left-turning vehicles from each of the four directions must intersect and cross over at grade through the left-turning traffic from two other directions. This difficulty is ameliorated by the fact that the crossover is accomplished in a length of travel in which the two traffic flows travel together in the same direction so that a weaving action of merging and diverging can take place fairly satisfactorily. But the length of the weaving section required to accommodate the volume of traffic increases the objections stated in Points 1 and 2.

It is interesting to note that the cloverleaf does not fully eliminate interference of traffic flow in the case of left-turning traffic although the sole purpose of the spread-out cloverleaf design is to accommodate left-turning traffic. Straight-through traffic is fully accommodated by the bridge at the intersection, and right-turning traffic is no

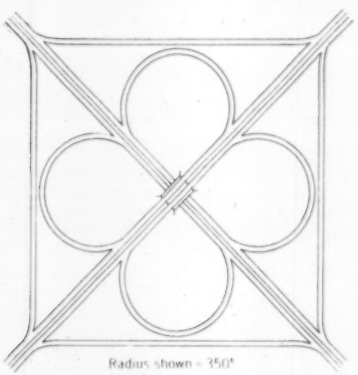



**FIG. 1. Standard cloverleaf has three disadvantages—large area required, additional travel for each vehicle left-turn, and double weaving movements required for making a left turn.**

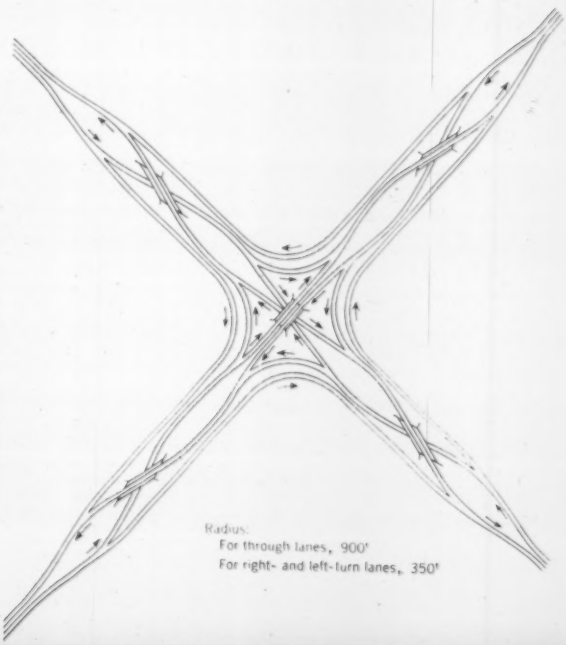



**FIG. 2. "Crossover" type of intersection eliminates disadvantages of standard cloverleaf. If structures instead of natural-slope embankments are used (now common practice in urban areas), the space required would be no greater than that needed for a traffic circle at the intersection of two major city streets.**

problem since it naturally does not cross other traffic lanes and could be accommodated by small turning lanes near the intersection.

To replace the standard cloverleaf, an improved type of grade-separated highway intersection, as shown in Fig. 2, is here recommended. Comparing this with Fig. 1 or with the layout of any of the more modern "directional-ramp" types of intersection, it can be seen that considerably less acreage is required. Also, the shape of the area conforms more nearly to the normal property lines along the two highways.

The area required for the proposed intersection, as shown in Fig. 2, is based on the use of earth embankments with side slopes of 1 vertical on 2 horizontal for all bridge approaches. If structures instead of natural-slope embankments are used (now common practice in modern expressway construction in urban areas), the area required would be no greater than that needed for a traffic circle at the intersection of two major city streets.

For this type of interchange no traffic crossovers are required, all vehicle movements are accomplished directly and without the need for weaving. All driver movements are natural—right-turning vehicles keep to the right, left-turning vehicles to the left, and through traffic to the middle. Also, there is a saving of 2,250 ft of vehicle-travel for each left-turning vehicle.

A stringent limitation on this proposal is that it should be applied only where two major highways intersect and there is a substantial amount of traffic in each of the twelve possible types of movement. This is because this proposal cannot be applied partially. If at any one of the eight points at which a left-turning vehicle must cross another lane, the volume of traffic is low enough to permit a crossing at grade, then the advantage of this type of intersection is substantially reduced. Also, this type of intersection introduces curves on the route of straight-through traffic. Unless the volume of turn-out traffic is substantial, the introduction of these curves for straight-through traffic would not be justified.

The only disadvantage of this type of intersection as compared to the cloverleaf is that it requires four additional bridges, which are major cost items. This disadvantage is reduced somewhat by the fact that for the main bridge at the center of the intersection both the width and the span are considerably less than for the comparable structure in a cloverleaf. This is because the traffic at the bridge, both over and under, consists only of straight-through vehicles. In the cloverleaf, every left-turning vehicle from all four directions must use this center bridge, resulting in four acceleration-deceleration-weaving lanes which increase both the width and the span of the bridge by two full lanes.

The disadvantage of the additional bridges disappears completely when the proposed intersection is compared with the "directional-ramp" type. In that type a total of nine bridges is required for a complete grade-separation.

# THE READERS WRITE

## About the "Manning formula"

To THE EDITOR: Professor Powell's letter in the June 1958 issue (p. 69), about the "Manning formula," prompts me to make the following comments:

1. The two forms of the Manning formula,

$$V = CS^{1/2}R^{2/3} \quad \text{(Form A)}$$

and

$$V = C_1\sqrt{Sg}\left[\sqrt{R} + \frac{0.22}{\sqrt{m}}(R - 0.15\,m)\right] \quad \text{(Form B)}$$

are equivalent, Form B being merely an attempt to find a dimensionless formula giving the same results as Form A but one that would be easier to solve by the methods of the nineteenth century.

2. Hagen's 1854 and 1868 papers, referred to by Houk, do not contain the "Gauckler-Hagen-Manning-Strickler formula."

In his 1889 paper (p. 175), Manning gave the result of his analysis of Bazin's data in the following form:

$$V = C\,S^{1/2}R^{2/3}$$

He applied this formula to the data of Bazin, Kutter, Ftely and Stearns, and Humphrey and Abbot. The agreement was good except for the Mississippi River data of Humphrey and Abbot. Manning stated (p. 183) that Form A "has the practical disadvantage of requiring the extraction of a cube root which is tedious by the arithmetical process." He suggested that "a formula may be put in the shape,

$$V = C\sqrt{Sg}\,[R^{1/2} + f(R)]$$

from which Formula I [that is, Form B] has been deduced by the author and which closely agreed with Formula V [that is, Form A] within certain limits."

Rewriting both formulas so that $R$ can be expressed in feet results in

$$V = C_2S^{1/2}R^{2/3}$$

$$V = C_2S^{1/2}\left(R^{1/2} + \frac{R}{7} - 0.05\right)$$

The difference between these two forms is less than 5 percent for all values of $R$ between 2 ft and 50 ft and less than 2 percent for values of $R$ between 3 ft and 35 ft. In the final form of the equation $C_2$ is replaced by $C_1\sqrt{g}$ so as to make the coefficient dimensionless. In addition, the dimensional constants 7 and 0.05 are avoided by the introduction of $m$, the height of the mercury barometer, which has an average value of 2.5 ft. These changes result in:

$$V = C_1\sqrt{Sg}\left[R^{1/2} + \frac{0.22}{\sqrt{m}}(R - 0.15\,m)\right]$$

which is Form B of the Manning formula.

The statement by Houk (p. 212 of Part IV of the Miami Reports) about Hagen and Gauckler, that "their work was recorded by Hagen in *Abhandlungen der Königlichen Akademie der Wissenschaften*, Berlin, 1854 and 1869. . . ." is quite misleading. Hagen's paper, "Uber den Einfluss der Temperature auf die Bewegung des Wassers," was presented to the Academy in November 1853 and March 1854 and included in the 1854 *Abhandlungen* which were published in 1855. This paper does not present information on open-channel flow. Hagen's paper, "Uber die Bewegung des Wassers in Stpomen," was presented in May 1867 and July 1868 and included in the *Abhandlungen* for 1868, which was published in 1869. The latter paper presents the formula,

$$V = 4.39\,R^{1/2}S^{1/2}$$

for open-channel flow, in which the low value of the slope exponent is due to the influence of the ever-intruding Mississippi River results of Humphrey and Abbot. There is no reference to Gauckler's work in the paper.

The spread of the use of the "Gauckler-Hagen-Manning-Strickler" formula is difficult to trace. Form B of the Manning equation appeared in a number of works between 1890 and 1920 but after the latter date Form A is much more frequently found. Thus, in the case of Gibson's *Hydraulics*, Form B appeared in the first (1908) and second (1912) editions but was replaced, without comment, by Form A in the third (1925) and later editions.

As I am at the moment engaged in writing a life history of Robert Manning, I am very much interested in the response to Professor Powell's request for information on early references to either form of the Manning formula.

JAMES C. I. DOOGE, A.M. ASCE
*Prof. of Civil Eng.,*
*University College*

*Cork, Ireland*

TO THE EDITOR: I would like to comment on the letter by Professor Powell about the Manning formula, in your June issue (p. 69). Professor Powell quotes Parker's *Control of Water,* which incidentally was published in 1913, not 1915 as stated. In it Parker gave the name of Manning's original paper as "On the Flow of Water in Channels and Pipes," but he did not give the date or place of publication.

This reference can be found in early editions of Gibson's *Hydraulics* and in *Applied Fluid Mechanics,* by O'Brien and Hickox (McGraw-Hill Book Co.). The correct reference to the original paper by Manning is "The Flow of Water in Open Channels and Pipes," *Transactions* of the Institution of Civil Engineers of Ireland, 1890.

Professor Rouse, in his *Mechanics of Fluid Resistance,* refers to Manning's formula but gives no reference to the original paper even though he gives the reference to von Mise's "relative roughness factor" on the same page.

Professor Powell may have difficulty in getting access to a copy of Manning's original paper. In that case he might refer to a paper by Erik Lindquist of Stockholm on "Various Formulae for Open Channels and Pipes," published in the *Transactions* of the World Power Conference, Sectional Meeting, Scandinavia, 1933, which should be accessible in American libraries. Lindquist gives a scholarly discussion of various formulas for flow in open channels and deals with Manning's formula, its origin and its relative value.

H. N. WALSH, M.I.C.E.I.
and M.I.C.E.
*Consulting Engineer*

*Cork, Ireland*

TO THE EDITOR: The writer had occasion recently to review hydraulic formulas for flow in open channels, and as Prof. Powell reported in the June issue (p. 69), also found that the origin of the so-called Manning formula was obscure. Several writers about the turn of the century recommended flow formulas in which the exponents of $R$ and $S$ were respectively $\frac{2}{3}$ and $\frac{1}{2}$, and your contributor may be interested in the following additional references.

In 1894, Crimp and Bruges, writing in the *Proceedings* of the Institution of Civil Engineers (England) recommended the equation,

$$V = 124\ R^{\frac{2}{3}}\ S^{\frac{1}{2}}$$

for sewers and water mains, and this equation is still in general use for sewer design by municipal engineers in England. C. H. Tutton, in a paper, "The Flow of Water in Pipes," presented to the Association of Engineering Societies (Boston) in 1899, considered the equation, $V = CR^{\frac{2}{3}}\ S^{\frac{1}{2}}$ in comparison with Kutter's formula, and arrived at

$$V = \frac{1.54}{n}\ R^{\frac{2}{3}}\ S^{\frac{1}{2}}$$

The writer believes this to be the earliest attempt to use Kutter's $n$ in a Manning-type equation. Fidler's book, *Calculations in Hydraulic Engineering* (1902), reviewed flow equations and recommended

$$V = C'\ R^{\frac{2}{3}}\ S^{\alpha}$$

with $\alpha = 0.55$ for the smooth classes of construction and $\alpha = 0.50$ for rough categories, but made no reference to Manning's 1891 and 1895 papers.

Two reference books by R. B. Buckley were published in 1908 and 1911. The former, *Facts, Figures and Formulae for Irrigation Engineers,* does not quote the Manning equation although it refers to his paper. The second, *Design of Channels for Irrigation or Drainage,* quotes and names the modern form of the Manning equation, and moreover demonstrates that at $R = 1$ meter, it becomes identical with the Kutter equation with an equal roughness coefficient.

To the writer's knowledge, this is the earliest reference to the Manning equation as we know it.

P. ACKERS, A.M.I.C.E.
*Senior Scientific Officer,*
*Hydraulics Research Station*

*Wallingford, Berkshire, England*

## Reply summarizes facts on "Manning" formula

TO THE EDITOR: These letters throw additional light on the subject. I believe Prof. Dooge should have said that Forms A and B are "roughly equivalent" rather than "equivalent," because as he says further on, the difference may be as much as 5 percent. In fact the difference would be 9 percent for $R = 1$ ft and even more for smaller values of $R$, unless a different $C$ were used in Form B than in Form A.

In reply to Mr. Walsh, I would say that I read both of Manning's papers some years ago in the Engineering Societies Library in New York. I have not yet been able to secure a copy of Linquist's paper but thank him for the reference.

Mr. Acker's letter is especially appreciated, as he seems to have located the first publication of the "Manning formula" as we know it today. In the light of his letter and my previous information it appears that the significant chronology of the subject is as follows:

1868—Gauckler proposed the formula, $V = C\ R^{\frac{2}{3}}\ S^{\frac{1}{2}}$ but limited it to certain values of $S$.

1881—Hagen (apparently unaware of Gauckler's work) derived the same formula from Kutter's data.

1889—Manning in a paper presented Dec. 4 (but not published until 1891) gave the same formula (without credit to Gauckler or Hagen) but recommended what Professor Dooge calls Form B as preferable.

1894—Crimp and Bruges recommended the same formula with $C = 124$. Whether they made use of the earlier publications, I do not know.

1899—Tutton made the important suggestion that $C = 1.54/n$, where $n$ is Kutter's $n$. As this differs less than 4 percent from what we now call the Manning formula, it is surprising that it seems never to have attracted any attention.

1911—Buckley gave us our present formula. He introduced the constant 1.486 so that $n$ would have the same value as in Kutter's formula when $R = 1$ meter. For him to give the resulting formula the name of Manning seems as uncalled for as for Clemens Herschel to name his meter after Venturi. But neither name will ever be changed.

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*Emeritus Prof. of Eng. Mechanics*
*The Ohio State University*

*Sherman Oaks, Calif.*

## Pole embedment needs systematic study

TO THE EDITOR: In the July 1958 issue (p. 69) in an article by Donald Patterson, M.ASCE, entitled "Pole Embedment to Resist Lateral Load," the author commented on my brief article in the March 1958 issue (p. 66) and on the article by N. G. Robbins in the April 1957 issue (p. 70).

Mr. Patterson said that both articles "appear to fall short of the purpose stated in their titles through attempting to oversimplify a complex problem. In both articles the basic assumption is made that the maximum value for passive earth pressure can be used, and the angle of internal friction is taken as 33°41′. This value implies a soil equivalent to a dry sand."

I wish to make it clear that I did not intend "to oversimplify a complex problem." My purpose was to present a graph similar to that given by Mr. Robbins, for the same soil as he used, and using the classic soil pressure distribution which can be found in *Soil Mechanics* by D. P. Krynine. For this chart I selected, as a criterion, the pressure at the base of the pole which is a more reliable one in my estimation. No new theory or generalization for various types of soils was intended. Mr. Rutledge's chart is of course a step forward toward the study of this subject, notwithstanding the simplifications it contains.

This subject needs a theory based on systematic laboratory and field work in order to rank with other accepted and verified methods. Otherwise it will still remain in a class where personal preferences for various formulas will govern.

IVAN M. NELIDOV, M.ASCE
*Civil Engineer*

*San Francisco, Calif.*

## Can engineering teaching be improved?

To THE EDITOR: Engineering educators the country over must have eagerly read C. E. Carver's article, "How Can Engineering Teaching Be Improved?" in the August 1958 issue, p. 44. His thoughts were stimulating yet there seemed to be a number of holes which were bridged over in this complex problem as well as some tacit assumptions.

First, where do the potential instructors come from? Mr. Carver says from the student body. Yes, but often there is a time lag. Some make the decision to enter the teaching profession while still in school, but a large percentage of our teaching staffs have worked from three to five years or more before they decided to become teachers. The engineering profession now contains a good many such people who would enter the teaching profession except for the fact that it would be economically unreasonable for them to do so. Yet every good college faculty needs this kind of personnel to balance its curriculum and lend realism to its offerings. These people are as indispensable as the highly trained theoretical and strictly academic people.

In Mr. Carver's opening statement, "Maybe Mr. X knows his stuff, but he certainly can't put it across," the assumption is made that the student is able to judge what is being "put across." Is the student in such a position? In numerous cases the instructor does know the material but he has lazy students who wish to be spoon fed—who want it all on a silver platter.

A desire for more knowledge usually leads the prospective teacher to study for advanced degrees. And in most institutions the man working toward a degree can get some teaching experience if he wishes it. In fact, if he is working toward a Doctor's degree he is probably on a teaching staff already. These are not all good teachers. What instructor is there who has not had an eager Ph.D student as his teacher while in school? Does he remember how the predoctoral instructor got off the subject and talked about his own project? Or how the faculty man, engrossed in the demands of his research, could only relate the subject at hand to his own particular kind of research? These are definite psychological problems the student must face.

Mr. Carver advocates a concentrated course in the art of teaching. This is an excellent suggestion, but when? Should it be added to the already crowded course work, should it be undertaken as a matter of course for all Ph.D.'s, or should it come when actual teaching begins? There is much to be said for each of these, but it would seem most productive to have such a course run concurrently with the first teaching assignment. The new teacher should be assigned a reduced teaching load to compensate for the added time the course takes. A good text for the start of such a course is a manual already in print, *Effective Teaching—A Manual for Engineering Instructors*, by Fred C. Morris (McGraw-Hill Book Co., New York, N. Y.).

As mentioned above, another thing that would improve teaching would be an attractive instead of a repellent salary scale. Pyschologically, a greater understanding on the part of the public of the professor's activities would raise the prestige of the engineering teaching profession and improve teaching.

But the student cannot be left out. If our colleges are more selective in choosing students the quality of the teaching will improve. The truth of this statement will be self-evident to those who were teaching during the war years, when students received A's who now would get C's and D's.

We can train the teacher to perfection as we train a dog to speak, but this of itself will not improve his teaching. Real improvement can only come when the teacher himself wishes to improve. Even an eager teacher, bent on self improvement, soon meets the most formidable adversary yet. How does he know when he has improved? How and by what standards can he judge the quality of his instruction? Who should set such standards, the teacher or the student who learns? This is the most critical problem facing education today. Educators the world over, and others interested, are rushing to and fro like ants in a disturbed hill trying to answer this question of how to measure teaching ability. It is a challenge to every teacher, every administrator, every student.

ROBERT B. HARRIS, A.M.ASCE
*Assoc. Prof. of Civil Eng.,*
*Univ. of Mich.*

*Ann Arbor, Mich.*

## Prefab buildings often encourage unethical practices

To THE EDITOR: Your July 1958 issue contained an article by Maurice Schulzinger entitled "Buy a Whole Building, Save Design Time." It is unfortunate that a fine technical and professional magazine should include such a promotional piece of journalism and especially as one of the feature articles. Some rebuttal is in order so that some who may have read the article will not accept it at its face value. Unfortunately, not all who read the article will see this letter.

Mr. Schulzinger states that "engineers have learned to rely on manufacturers' catalogues for data on available sections and their structural properties." He then concludes that we should feel just as confident and ethical in selecting a building system from a catalogue.

This is a very poor analogy. Certainly we take the properties of wide-flange beams and joists from catalogues, but so does Mr. Schulzinger in designing his prefab building. However, we then use these structural members to design a building to suit the client's needs, much as a mechanical engineer uses a motor or fan to fit into his mechanical system.

An architect or engineer has an ethical responsibility to render professional service and advice to his client. This doesn't mean merely to demonstrate his ability as a designer; he also must guide the client in planning not only for his present needs but also for future possibilities. This type of service is not being provided when a standardized building is sold merely on the basis of low first cost.

I know of clients who have purchased standardized buildings and then had to hire a consulting firm to design the foundations. To keep the size of members to a minimum, the manufacturer had placed an additional burden on the foundation by requiring a fixed connection at the column base and by using non-standard base details, thus causing more expensive concrete construction details. Also I have been called in to advise a client as to how he could strengthen his prefab building to meet new load requirements.

I certainly disagree with the author's statement that an engineering firm's profits will be greater by using a prefab building since most projects are designed on a percentage-of-cost basis. This would probably be true if an engineering firm did specify such a building. However, I fail to see why a client would be foolish enough to pay a consulting firm to select a standard building out of a catalogue when he could deal directly with the prefab company and thus save the percentage.

I know of many cases in which the standardized building people contacted the client directly and told him how cheaply they could put up a building for him. The consulting firm is then asked by the client for an estimate of what its building will cost. The consultant ends up practically bidding against the prefab company. This certainly is not an ethical procedure. It is only natural for consultants to resent this intrusion into their field and to consider it unethical to specify Mr. Schulzinger's type of building.

It seems to me that Mr. Schulzinger owes CIVIL ENGINEERING the price of a two-page advertisement.

LOUIS A. BACON, M.ASCE
*Chief Structural Engr.*
*Shaw Metz & Dolio*

*Chicago, Ill.*

AMERICAN SOCIETY OF CIVIL ENGINEERS

# Conference on Electronic Computation

Sponsored by the Committee on Electronic Computation, Structural Division, and the Kansas City Section

**Continental Hotel, Kansas City, Mo.** **Nov. 20-21, 1958**

## REGISTRATION

A Registration Desk will be maintained in the lobby of the Continental Hotel. No registration fee will be charged. Conference participants are urged to preregister early.

Printed programs, together with preregistration and hotel reservation blanks are being mailed to all ASCE members in the Structural and Engineering Mechanics Divisions and in Districts 14 and 16.

Additional programs are obtainable from Frank M. Cortelyou, Jr., 802 Dwight Building, 1004 Baltimore, Kansas City, Mo.

## COMMITTEE ON ELECTRONIC COMPUTATION MEETS

**Wed., Nov. 19, 7:30 p.m.**

This is a business meeting of the Committee. Conference participants are invited to attend.

## HOTEL ACCOMMODATIONS

Room reservations at the Continental Hotel are to be handled directly by the Conference participants.

## COMPUTER DEMONSTRATIONS

**Thursday through Saturday**

Manufacturers of commercial computers will conduct demonstrations throughout the Conference.

## AUTHORS' BREAKFASTS

**7:30 a.m. Thursday and Friday**

By invitation only.

## THURSDAY LUNCHEON

**12:30 p.m.**

*Speaker:* Dr. H. R. J. Grosch, Special Assistant to the Director of Marketing Programs, Data Processing Div., International Business Machines Corp., White Plains, N. Y.

*Subject:* Universal Computer Language

Tickets for this event will be available at the Registration Desk. Tickets must be purchased by 10:30 a.m. Thursday.

## THURSDAY MORNING

## NOV. 20

### General Session

*Presiding: N. M. Newmark, Chairman, Committee on Electronic Computation, Structural Div.*

**9:00 Greetings**

Josef Sorkin, M. ASCE, Chairman, Kansas City Sect. Committee, Conference on Electronic Computation.

**9:10 Welcome Address**

N. M. Newmark, M. ASCE, Head, Dept. of Civil Eng., Univ. of Illinois, Urbana.

**9:30 Keynote Address**

To be announced.

**10:15 Intermission**

**10:30 A Method of Applying the Electronic Computer to Roof-Truss Proportioning**

Gordon M. Gray, A.M. ASCE, Capt., USAF, Instructor, Dept. of Mechanics, U. S. Air Force Academy, Colorado Springs, Colo.

**11:15 The Impact of Digital Computers on Engineering Education**

Gordon P. Fisher, A.M. ASCE, Assoc. Prof. of Civil Eng., Cornell Univ., Ithaca, N. Y.

## THURSDAY AFTERNOON

## NOV. 20

### Mathematical Methods, Session A

*Presiding: John J. Kozak, Chairman, Task Committee on Program Directory and Library, Committee on Electronic Computation, Structural Div.*

**2:00 On the Computer Solution of Algebraic Equations**

Glen V. Berg, A.M. ASCE, Asst. Prof. of Civil Eng., Univ. of Michigan, Ann Arbor.

**2:40 Numerical Integration by the Beta Method**

John W. Melin. J.M. ASCE, Research Associate, Dept. of Civil Eng., Univ. of Illinois, Urbana.

**3:20 Intermission**

**3:35 Matric Formulation of Slope-Deflection Equations**

C. K. Wang, M. ASCE, Prof. of Architectural Eng., Univ. of Illinois, Urbana.

**4:15 Analysis of Space Structures**

Sidney Shore, M. ASCE, Assoc. Prof. of Civil Eng., Univ. of Pennsylvania, Philadelphia.

### Programming, Coding, and Organization Session

*Presiding: Charles W. Zahler, Chairman, Task Committee on Statistical Applications, Committee on Electronic Computation, Structural Div.*

**2:00 Fundamental Concepts of Programming**

STEVEN J. FENVES, J.M. ASCE, Instr. in Civil Eng., Univ. of Illinois, Urbana.

**2:40 Introduction to Matrix Algebra**

RAY R. BERMAN, A.M. ASCE, Applications Engr., Bendix Computer Div., Los Angeles, Calif.

**3:20 Intermission**

**3:35 Organizing for Computing in a Firm of Consultants**

WINFIELD O. SALTER, J.M. ASCE, Deputy Chief Highway Engr., Parsons, Brinkerhoff, Hall & Macdonald, New York, N. Y.

**4:15 Analyze and Program to Exploit the Computer**

ELMER C. KUBIE, President, Computer Usage Co., Inc., New York, N. Y.

## SOCIAL HOUR

Thursday, 5:30 p.m.

This event is sponsored by the Kansas City Section. Free tickets will be available at the Registration Desk for all Conference participants.

## COMPUTER SEMINAR

Thursday, 7:30 to 9:30 p.m.

Short, informative seminars will be conducted by the computer manufacturers exhibiting at the Conference. Details will be available at the Registration Desk.

## FRIDAY MORNING

## NOV. 21

### Mathematical Methods, Session B

*Presiding: Glen V. Berg, Chairman, Task Committee on Mathematical Methods, Committee on Electronic Computation, Structural Div.*

**8:30 Digital Computer Solutions of the Dynamic Column Buckling Equations**

EUGENE SEVIN, Senior Research Engr., Armour Research Foundation, Chicago, Ill.

**9:15 Structural Analysis by Means of a Matrix Algebra Program**

RAY W. CLOUGH, A.M. ASCE, Assoc. Prof. of Civil Eng., Univ. of California, Berkeley.

**10:00 Intermission**

**10:15 The Use of a Transformation Chain in Matrix Structural Analysis**

FRANK R. BERMAN, Supervising Engr., Seelye, Stevenson, Value & Knecht, New York, N. Y.

**11:00 Ill-Conditioned Equations and Matrices**

ROBERT B. MCCALLEY, JR., A.M. ASCE, Div. of Reactor Development, U. S. Atomic Energy Commission, Washington, D. C.

### Structural Design, Session A

*Presiding: Jackson L. Durkee, Chairman, Task Committee on Publications and Technical Sessions, Committee on Electronic Computation, Structural Div.*

**8:30 The Use of a Small Computer in Structural Design**

JOHN A. TIERNEY, J.M. ASCE, Programmer, Parsons, Brinckerhoff, Hall & Macdonald, New York, N. Y.

**9:15 Rigid-Frame Analysis with a Digital Computer**

ROBERT A. BARNESON, The Fluor Corp., Ltd., Whittier, Calif.

**10:00 Intermission**

**10:15 Computer Analysis of Continuous I-Beam Bridges**

NEIL WELDEN, A.M. ASCE, Bridge Engr., JAMES S. HOFFMAN, J.M. ASCE, and ALBERT R. TORKILDSON, Programming Engineers, Iowa State Highway Comm., Ames, Iowa.

**11:00 The Use of Electronic Computations in the Analysis of Continuous Girder and Rigid Frame Bridges with Variable Moments of Inertia**

SABRI SAMI, A.M. ASCE, Prof. of Civil Eng., West Virginia Univ., Morgantown.

## FRIDAY LUNCHEON

12:30 p.m.

*Speaker:* ELMER K. TIMBY, Member, Exec. Committee, Structural Div.

*Subject:* Electronic Computation in Civil Engineering

Tickets for this event will be available at the Registration Desk. Tickets must be purchased by 10:30 a.m. Friday.

## FRIDAY AFTERNOON

## NOV. 21

### Structural Design, Session B

*Presiding: George S. Vincent, Chairman, Exec. Committee, Structural Div.*

**2:00 Stress Analysis of Trusses on a Digital Computer**

C. W. ZAHLER, M. ASCE, Engineer-Electronics, U.S. Steel Corp., and J. E. O'KEEFE, A.M. ASCE, Engr., Mechanized Functions, Amer. Bridge Div., U.S. Steel Corp., Pittsburgh, Pa.

**2:40 Analysis of Continuous Truss by Digital Computer**

JERRY C. L. CHANG, A.M. ASCE, Principal Asst. Engr.; THOMAS D. Y. FOK, A.M. ASCE, Design Engr., Richardson, Gordon & Associates, Pittsburgh, Pa.; and FRANK J. CVETIC, Customer Engr., Bendix Computer Div., Los Angeles, Calif.

**3:20 Intermission**

**3:35 Suspension Bridge Truss Analysis by Electronic Computer**

CLIFFORD P. KUNTZ, A.M. ASCE, Structural Designer, Port of New York Authority, New York; JAMES P. AVERY, Asst. Engr.; and JACKSON L. DURKEE, A.M. ASCE, Senior Designer, Fabricated Steel Construction, Bethlehem Steel Co., Bethlehem, Pa.

**4:15 Structural Design by High-Speed Computing Machines**

CARL E. PEARSON, Advanced Research Div., Arthur D. Little, Inc., Cambridge, Mass.

## COMPUTER SEMINAR

Friday, 7:30 to 9:30 p.m.

Details of this seminar will be available at the Registration Desk.

# SOCIETY NEWS

## Ten New Officers to Be Installed at Annual Convention

### Highlights in the Careers of New ASCE Officers

#### Francis S. Friel

Francis S. Friel, who will take office in October as 90th President of the Society, has an international reputation in the engineering field. As president of the Philadelphia consulting firm of Albright & Friel, he is a specialist in water supply and purification projects, sewage treatment works, refuse collection and incineration projects, industrial waste disposal, power plants, and dams. He has been in the consulting field for 37 years —for 27 years as a member of Albright & Friel, in charge of all engineering and management. He has been president of the firm since 1945.

During Mr. Friel's long association with the firm he has done important work on more than 2,065 different civil engineering projects with a construction cost of more than $1,250,000,000. Among these were 343 water supply projects, 114 industrial waste treatment plants, and 31 dams. Particularly outstanding were his services as consultant on flood control problems for the Miami Conservancy District and on the design and construction of the Aberdeen (Md.) Proving Grounds. A current government assignment is that of member of the Congressional Board of Consultants for a study of the Panama Canal. His firm is also studying the possibility of a new water supply for New York City. His long career has been interrupted only by service in the Corps of Engineers in World War I. He was with the 304th Engineers in France, and for many years was a major in the Corps of Engineers Reserve. During World War II his firm built a number of military airports and designed water supply systems for 24 Army and Navy projects.

A 1916 graduate of Drexel Institute of Technology, Mr. Friel received the honorary degree of doctor of engineering there in 1949 and the Alumni Award for Distinguished Service in Engineering in 1950. He is now vice-chairman of the Drexel Board of Trustees and chairman of its Building and Fund Raising Committees. Recent honors accorded Mr. Friel include the Medal of the American Public Works Association, which was awarded him in 1948. In 1956 he was named Philadelphia's "Engineer of the Year" by the local engineering societies.

**FRANCIS S. FRIEL**
**President-Elect of ASCE**

Becoming an Associate Member of ASCE in 1921 and Member in 1926, Mr. Friel served as Director from 1950 through 1953 and is currently completing a two-year term as Vice-President. In addition, he has served on seventeen Society committees. Active also in the Philadelphia Section, he has been a director and vice-president, and was president for two terms.

Mr. Friel's numerous other affiliations include the American Institute of Consulting Engineers, the Federation of Sewage and Industrial Wastes Associations, and the Pennsylvania Sewage Works Association, all of which he has served as president. He is currently chairman of the U.S. National Committee of the International Commission on Large Dams, which was host to the Sixth International Congress on Large Dams in New York City this September. He is also an alternate on the executive committee of the World Power Congress. He has represented the United States at many international meetings and congresses—Large Dams, World Power, Soil Mechanics, and Hydraulics, to mention a few.

#### Paul L. Holland

Paul L. Holland, the new ASCE Vice-President for Zone II, is chief engineer of the Anne Arundel County Sanitary Commission, with headquarters at Glen Burnie, Md. Versatility marks Mr. Holland's career, which has included fifteen years in Naval service, public utility experience, municipal employment, and periods in consulting practice.

A 1908 graduate of the U. S. Naval Academy, Mr. Holland filled various assignments for the Navy in ordnance and gunnery, seamanship, navigation and engineering and was an instructor at the Academy for several years. He retired from the Navy in December 1919, with the rank of lieutenant commander. For the next five years Mr. Holland engaged in public utility operation in the Southeastern states. He held the positions of staff engineer, assistant manager, and chief engineer on every phase of electric power generation, transmission, and sale. From 1925 to 1931 he was with Mees and Mees, Charlotte, N. C., consultants, engaged in office and field work on hydro and steam-electric plants.

From 1931 to 1948 Mr. Holland was chief engineer of the Maryland Public Service Commission. This work involved professional and administrative duties in connection with all state utilities and appraisals of property totaling $100,000,000. As director of public works for the City of Baltimore from 1948 to 1954, Mr. Holland supervised engineering expenditures totaling $240,000,000. After leaving city service, he was regional manager for John McShain, Philadelphia builder,

**PAUL L. HOLLAND**
**Vice-President, Zone II**

**LLOYD D. KNAPP**
**Vice-President, Zone III**

**THOMAS J. FRATAR**
**Director, District 1**

and an associate in the architectural office of Edward H. Glidden, Jr. He has been with Anne Arundel County since July 1956.

Long active in ASCE, Mr. Holland served a term as Director from 1948 to 1951. He has also been president of the Maryland Section.

### Lloyd D. Knapp

Lloyd D. Knapp, who recently served District 7 as Director, returns now to the Board of Direction as Vice-President for Zone III. Mr. Knapp has been in the engineering service of the City of Milwaukee for over thirty years and is now commissioner of public works.

Following his graduation from the University of Illinois with a civil engineering degree in 1915, Mr. Knapp became assistant engineer on railroad construction and maintenance for the Union Railway Company (Missouri Pacific Lines) at Memphis, Tenn. During the 1917-1919 period he was a lieutenant in the 306th Regiment of Engineers, serving in France. From 1919 to 1925 he was terminal engineer for the Texas Pacific-Missouri Pacific Terminal Railroad of New Orleans, in charge of maintenance and minor construction projects.

For the next twenty years Mr. Knapp was in the Milwaukee Bureau of Engineers in various positions, including engineer-in-charge of grade-crossing elimination and special projects. He became superintendent of the Bureau of Sewers in 1945 and city engineer in 1950. He has been commissioner of public works since 1956.

As Director of the Society for District 7 from 1953 to 1955, Mr. Knapp filled many ASCE committee assignments. In 1956 and 1957 he was chairman of the Task Committee on Study of Economic Advancement Objectives, and he is currently chairman of the Committee on Professional Practice. He has served the Wisconsin Section as secretary and treasurer and president, and for twelve years was Section Contact Member for Marquette University.

Special honors to Mr. Knapp include an Engineers Society of Milwaukee Citation as Engineer of the Year in 1956, and the Samuel A. Greeley Award of the American Public Works Association in the same year.

### Thomas J. Fratar

The new Society Director for District 1 is Thomas J. Fratar, general chairman of this year's Annual Convention Committee and a partner in the New York City consulting firm of Tippetts-Abbett-McCarthy-Stratton. Mr. Fratar joined the firm as associate partner in 1946, following World War II military service in the Persian Gulf Command. He has been a full partner in the firm since 1956. As a valuation engineer for the Third Military Railway Service, during the war, he was responsible for the coordination with the Iranian Government, the British Army, and the U.S. Army of the cost of new construction on the Iranian State Railway.

In his association with Tippetts-Abbett-McCarthy-Stratton, Mr. Fratar has been responsible for a number of comprehensive traffic, transportation, and economic studies for highway, bridge, and tunnel projects, port development plans, and multi-purpose river development schemes. While directing highway planning and traffic surveys, he developed a successive approximation procedure for estimating the intrazonal and interzonal movements of traffic. This method has been approved in plan by the U. S. Bureau of Public Roads, and is now in wide use in traffic surveys for urban areas.

Mr. Fratar graduated from Rensselaer Polytechnic Institute with the civil engineering degree in 1936 and from Yale University with a master of engineering degree in 1942. His early experience was as chief of party and field engineer for Madigan-Hyland and as research analyst for the Yale Bureau for Street Traffic Research. He has also served as consultant on transportation to the civil engineering department at Northwestern University. Mr. Fratar is author of a number of articles and reports, some of which have appeared as Highway Research Board bulletins, and co-author of the traffic engineering section of the handbook, *American Civil Engineering Practice*.

In addition to serving as chairman of the New York Annual Convention Committee that is in charge of the forthcoming October Convention, Mr. Fratar is currently serving the Society as a member of the Committee on Highway Planning and Finance, the Committee on Ports and Harbors, and the Committee on Cooperation with Local Sections and Regional Councils. He has also been chairman of the Local Qualifications Committee for District 1 and of the Metropolitan Section Committee on Junior Members.

### Earl F. O'Brien

Earl F. O'Brien, new Director for District 3, is a partner in the consulting engineering firm of O'Brien & Gere, Syracuse, N. Y. A 1920 civil engineering graduate of Cornell University, Mr. O'Brien was on the staff of the Syracuse Intercepting Sewer Board as a design engineer from 1923 to 1931. During this period he was concerned with the development of extensive sewerage and sewage treatment plant facilities under the guidance of Glenn D. Holmes, M.ASCE.

After two years in private practice, Mr. O'Brien served for six years as design engineer for the Onondaga Public Works Commission, which is responsible for the development of trunk-sewer and sewage-treatment facilities on a metropolitan basis for Onondaga County

**EARL F. O'BRIEN**
Director, District 3

**D. B. VENTRES**
Director, District 5

**CHARLES W. BRITZIUS**
Director, District 7

(New York). During World War II he served in Washington, D. C., with the War Production Board. In 1944 he returned to private consulting practice in Syracuse as a partner in Holmes, O'Brien & Gere, predecessor to the present firm.

Mr. O'Brien's firm is now engaged in the design and supervision of construction of sanitary or industrial waste facilities for numerous private and public corporations including metropolitan Syracuse and the City of Poughkeepsie.

For the past six years Mr. O'Brien has served as a member of the Board of Examiners of Professional Engineers and Land Surveyors, New York State Department of Education. In 1955 he was appointed by Governor Harriman as a delegate to the New York State Conference on Education.

Long active in ASCE, Mr. O'Brien has been president of the Syracuse Section. He is also a past president of the Central New York Chapter of the New York State Society of Professional Engineers, one of his many professional affiliations.

### Daniel B. Ventres

The new Society Director for District 5 is Daniel B. Ventres, who recently retired after more than thirty-one years in Federal service. Captain Ventres is now engaged as consultant for and director of the Washington office of Vogt, Ivers, Seaman and Associates, an engineering and architectural firm with headquarters in Cincinnati.

A graduate of the University of Michigan in 1922 with a B.S. degree in engineering, he subsequently did graduate work in contracts at George Washington University and personnel management at American University. His long career in government service began in 1923, when he was appointed junior hydraulic engineer for the U. S. Geological Survey in the Chattanooga District. From 1925 to 1930 he served with the American Occupation of Haiti, where the public works program was administered by the Navy Civil Engineer Corps. During this period he was commissioned in the Navy Reserve. In the thirties he was with the Navy in the First Naval District in Boston, the Bureau of Public Roads in Denver, and the National Park Service.

Called to active duty in the Navy in 1939, he served as resident officer in charge of construction of Midway Island Naval Air Base, one of our most strategic bases. Among other wartime assignments he was officer in charge of construction of the Patuxent River (Md.) Naval Air Station and of the Advance Base Proving Grounds at Davisville, R. I. Finally he was senior staff civil engineer with the Seventh Fleet in the Pacific Theater. On inactive duty from 1946 to 1951, Captain Ventres served as chief of the Property Management Division of the Bureau of Reclamation. Recalled to active duty in 1951, he filled a variety of assignments for the Civil Engineer Corps. At the time of his retirement he was chief of the Engineering-Joint Construction Agency, in Paris, which handled military design and construction in Western Europe.

Captain Ventres has been active in ASCE for the past quarter of a century. His services to the National Capital Section include terms as treasurer, vice-president, and president.

### Charles W. Britzius

The new ASCE Director for District 7 is Charles W. Britzius, president of the Twin City Testing and Engineering Laboratory, Inc., St. Paul, Minn. Mr. Britzius was educated at the University of Minnesota, from which he received the B.S.C.E. degree in 1933. After early work with the Hall Testing Laboratory, Mr. Britzius returned to his alma mater to teach and was then employed by the Minnesota Highway Department. He received his M.S.C.E. degree from the University of Minnesota in 1938, and in the same year purchased the Hall Testing Laboratory, which he reorganized under the name of the Twin City Testing and Engineering Laboratory.

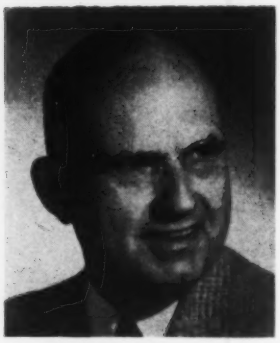
Long active in ASCE and the Northwestern Section, Mr. Britzius was president of the Section in 1951. His other professional affiliations include the Minnesota Society of Professional Engineers, which he is currently serving as president. He has also been president of the St. Paul Engineers Society. Mr. Britzius is identified with the civic interests of Deephaven, Minn., his home community, where he serves on the Deephaven Planning Commission and the Citizens Committee for Education.

### Wayne G. O'Harra

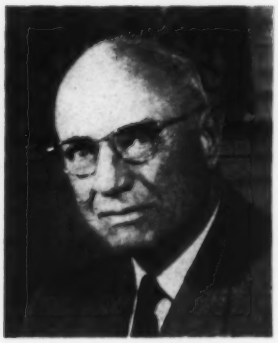
Wayne G. O'Harra, newly elected Director of District 11, is engineer of materials for the Arizona State Highway Department, Phoenix. As head of the Materials Division, he has complete responsibility for the structural design of all highway pavements, and for maintaining "quality-control" on all materials incorporated in Arizona highways.

Mr. O'Harra graduated from the South Dakota State School of Mines with a B.S. degree in metallurgical engineering in 1924, and received the degree of Civil Engineer from the same school in 1939. He is a licensed professional engineer in the State of Arizona. After his graduation he was employed as a chemist by the American Smelting and Refining Co., in Omaha, Nebr. In 1928 he joined the Arizona State Highway Department, where he was originally employed as a

**WAYNE G. O'HARRA**
**Director, District 11**



**FRED RHODES**
**Director, District 12**



**N. T. VEATCH**
**Director, District 16**

chemist. Through the years Mr. O'Harra has advanced through the grades of chemist, chief chemist, and assistant engineer of materials, to his present position as head of the Materials Division to which he was promoted in 1954. He has presented technical papers on construction materials and testing methods to technical sessions of ASCE and other engineering societies.

During his twenty-five years of association with the Society Mr. O'Harra has regularly participated in its activities. He was secretary of the executive committee of the Air Transport Division in 1952. In the Arizona Section, he has been secretary, vice-president, and president. He was chairman of the 1958 Pacific Southwest Conference.

Active also in other professional and technical groups, Mr. O'Harra is a member of the Committee on Materials, of the American Association of State Highway Officials, and a member of numerous committees of the Highway Research Board and the American Society for Testing Materials.

## Fred H. Rhodes

Fred H. Rhodes, Jr., professor of civil engineering at the University of Washington, Seattle, will represent District 12 on the Board of Direction. He graduated from the University of Washington with both civil and mechanical engineering degrees in 1926, and also has the professional degree of C.E. Immediately after his graduation he worked for structural steel fabricators in Seattle.

He has been on the University of Washington faculty since October 1927, with the exception of two years on leave of absence as a structural engineer in the bridge department of the Tacoma City Engineer's Office and a similar period as antiaircraft officer in the U.S. Army during the war. Professor Rhodes is now retired from the Army, with the rank of Lieutenant Colonel, after thirty years in the Reserve Corps.

In addition to consulting work on structures, Professor Rhodes has devoted considerable time to studies of highway safety. He is a trustee of the Automobile Club of Washington and chairman of its Committee on Traffic and Safety. He is also director of university short courses and conferences covering driver education in the high schools, motor vehicle fleet supervision, and maintenance of vehicles. Professor Rhodes' accomplishments in the safety field were recognized at the 1953 Governor's Safety Conference in Olympia, Wash., when he received the first annual Award for Achievement in Safety Education—named the Fred Rhodes Award in his honor.

Professor Rhodes has served ASCE in many capacities, including the chairmanship of the Committee on Local Sections, the Committee on Cooperation with Local Sections, and the Local Qualifications Committee for District 12. He was general chairman of the Society's Summer Convention when it met in Seattle in 1948, and chairman of the Pacific Northwest Council in 1953. He has also been secretary, vice-president, and president of the Seattle Section. Professor Rhodes' numerous other affiliations include the Society of American Military Engineers, which he served as local post president for three years.

## N. T. Veatch

District 16 will be represented on the Board of Direction by N. T. Veatch, member of the Kansas City (Mo.) consulting firm of Black & Veatch. Mr. Veatch graduated from the University of Kansas in 1909 and received his C.E. degree there in 1924. After early employment with the firm of Worley & Black, he spent a year in sanitary engineering work with the Kansas State Board of Health and in teaching at the University of Kansas. He then became connected with the American Water Works and Guarantee Company in Pittsburgh, and later was manager of the Keokuk, Iowa, water system, a property of that company.

In 1913 Mr. Veatch returned to Worley & Black as principal assistant, and in 1915—when Mr. Worley was called to the Interstate Sanitation Commission to conduct the valuation of the railroads of the country—the firm of Black & Veatch was formed. The firm, which specializes in engineering work for the major utilities serving industry, municipalities, and the federal government, has had assignments in almost every state.

Mr. Veatch has a long record of Society service. He has been chairman of the Executive Committee of the Sanitary Engineering Division and of the ASCE Committee on Professional Practice. Currently he is chairman of the ASCE Task Committee on Principles of Practice and of the local ASCE Qualifications Committee.

His service for other societies and agencies includes the presidency of the American Water Works Association. He has been on the Committee on Professional Practice of Consulting Engineering of the American Society of Mechanical Engineers. One very important assignment has been as a member of the President's Water Pollution Control Advisory Board.

# ASCE Has Three New Honorary Members

Three distinguished members of ASCE were elected to honorary membership in the Society during the recent Portland meeting of the Board of Direction. They are Henry J. Brunnier, consulting structural engineer of San Francisco; Nathan W. Dougherty, dean emeritus of the College of Engineering, University of Tennessee, Knoxville; and A M Rawn, chief engineer and general manager of the Los Angeles County Sanitation Districts. Presentation of their honorary memberships will be a feature of the Annual Convention this October.

A wide range of important engineering work and professional attainment is represented in the careers of the three engineers chosen to receive the Society's highest honor. The highlights in their careers are summarized here.

### Henry J. Brunnier

New Honorary Member Henry J. Brunnier is a consulting structural engineer in San Francisco. A world-renowned authority on earthquake-proof design and difficult foundation problems, he has been decorated by many foreign governments.

In 1904 Mr. Brunnier graduated from Iowa State College with a bachelor's degree in civil engineering, and in 1911 he received the C.E. degree from the same institution. His early employment was with the American Bridge Company, the New York Edison Company, and the Ford, Bacon and Davis Engineering Company. His life-long interest in earthquake-resistant design began in 1906, when Ford, Bacon and Davis sent him to San Francisco on structural work involved in rebuilding the city after the earthquake and fire.

Mr. Brunnier started his own consulting practice in San Francisco in 1908. In his half century of practice he has handled the structural work for many important Pacific Coast structures. Among these are the Russ Building, the Shell Oil Building, the Standard Oil Building, and the San Francisco Baseball Stadium, all in San Francisco; a number of important buildings for the University of California in Berkeley, Los Angeles, and Davis; and wharves at the Mare Island Navy Yard. In addition, he has been a consultant on important foundation and earthquake problems and engineering adviser to attorneys in legal cases involving structures. One of his important services was as a member of the five-man Board of Consulting Engineers on design and construction of the San Francisco-Oakland Bay Bridge.

In World War I Mr. Brunnier helped organize and manage the Concrete Ship Department for the U.S. Emergency Fleet Corporation. Just prior to and during World War II he handled $50,000,000 worth of work for the Navy Department in the Panama Canal Zone. His work there included the design and construction of submarine bases and buildings for the Naval Air Station.

Mr. Brunnier was the first president of the Structural Engineers Association of Northern California and served in that office for two years. In 1950 he was named "outstanding engineer" by the San Francisco Building Industry Conference Board, and in 1956 he was honored as "the outstanding Bay area engineer" in the National Engineers Week celebration. Among the foreign societies that have honored Mr. Brunnier are the Civil Engineering Society of Japan, the Architectural Institute of Japan, and El Institute de Ingenieros de Chile. He is also an officer in the French Legion of Honor.

Despite the claims of his busy career, Mr. Brunnier has found time to express his interest in a wide range of community, state, and national affairs. He was a member of the first board that activated the Registration Act for Civil Engineers in California. After many years of work in the local Rotary Club, he served as president of Rotary International in 1952 and 1953. From 1922 to 1929 he was president of the California State Automobile Association, and from 1935 to 1937 president of the American Automobile Association.

HENRY J. BRUNNIER
Hon. M. ASCE

NATHAN W. DOUGHERTY
Hon. M. ASCE

### Nathan W. Dougherty

Nathan W. Dougherty, new Honorary Member of the Society and dean emeritus of the University of Tennessee College of Engineering, has outstanding accomplishments to his credit in the fields of engineering education, professional recognition, and professional practice.

As an engineering educator, Dean Dougherty served the University of Tennessee for forty years. He was head of the civil engineering department for many years and dean of engineering for sixteen years. He graduated from the University of Tennessee in 1909 with a bachelor degree in civil engineering, and subsequently received C.E. and M.C.E. degrees from Cornell University. He was an instructor at Cornell from 1910 to 1914 and assistant professor of civil engineering at George Washington University from 1914 to 1916. In the latter year he went to the University of Tennessee, where he remained until his retirement in 1956. Since his retirement he has been acting as consultant to the Arnold Engineering Development Center at Tullahoma, Tenn.

Dean Dougherty's principal technical interest has been in highway engineering, and he has made important contributions to the field as engineer, author and editor. He helped organize the Highway Research Board, and for many years was an influential member. He was also a pioneer in the making of traffic surveys and the analysis of highway capacity.

Dean Dougherty has served the cause of professional recognition for engineers in many ways—perhaps most notably in his work for professional registration and licensing. He is widely known as an expert in the field, and is the author of a book on the subject. He helped draft the Tennessee registration law, and served on the Tennessee State Board of Architectural and Engineering Examiners from its inception in 1921 to 1956—for thirty years of this period as chairman. For many years, he was active in the National Council of State Boards of Engineering Examiners, which he has also served as chairman.

His interest in education has expressed

itself in a long association with the American Society of Engineering Education. He has been chairman of the Southeast Section, vice president, and member of the Council. His services culminated in the presidency in 1954 and 1955. He has also worked on the Education Committee of the Engineers Council for Professional Development and been chairman of the ECPD Student Development Committee.

Prominently identified with the work of the National Society of Professional Engineers and a former officer, Dean Dougherty received the 1958 NSPE award. He was cited for "his outstanding leadership in his profession as evidenced by his devotion to the advancement of engineering education, his sympathetic encouragement of students of engineering, his zealous promotion of the ideals and principles of his profession, and his humanitarian interest in his fellowmen."

A life member of ASCE, he served as Director from 1943 to 1946. He has also been president of the Tennessee Valley Section's Knoxville Branch.

### A M Rawn

A widely famed authority in the sanitary engineering field, new Honorary Member A M Rawn is chief engineer and general manager of the Los Angeles County Sanitation Districts. Mr. Rawn's advice on problems involved in the ocean disposal of sewage is valued all over the world. He is also known for his work in the fields of sewage collection, treatment, and disposal, industrial wastes and refuse disposal, and water pollution control.

Mr. Rawn's interest in engineering began in his high school days when he was employed during summer vacations as a land surveyor and instrumentman. Upon graduation from high school in 1909, he took a job on the construction of railroads and terminal warehouses in Mississippi and Louisiana. In 1912 he went West to join the U.S. Reclamation Service (now the Bureau of Reclamation), working as an engineer on the Yakima, Boise, Salt River, Columbia Basin, and King Hill projects. World War I found him in active military service in the Corps of Engineers, in which he rose from enlisted man to first lieutenant.

In 1924 Mr. Rawn left the Reclamation Service to become assistant chief engineer of the Los Angeles County Sanitation Districts. He has been chief engineer and general manager since 1941. Today the Sanitation Districts serve a population of some 2,700,000 with over 625 miles of trunk sewers and 5,100 miles of laterals.

Mr. Rawn has given unstintingly of his time to numerous consulting boards that have directed the development of sewage disposal projects for a number of California areas—San Francisco's East Bay communities, Orange County, Santa Clara County, and San Diego County, to mention a few. Further afield, he has advised on projects for Portland, Ore., Vancouver, B.C., and Auckland, N.Z. In addition, during World War II, he served as consultant to the Construction Quartermaster and as director of the Sewerage and Sanitation Branch of the War Production Board. More recently he became a charter member of the California State Water Pollution Control Board, of which he is now chairman. On the national scene he has served on the Federal Water Pollution Control Advisory Board.

**A M RAWN**
**Hon. M. ASCE**

Long active in Society affairs, Mr. Rawn was Director for District 11 from 1942 to 1944 and Vice President for Zone IV in 1952 and 1953. He has also been president of the Los Angeles Section and of the Los Angeles Council of Engineering Societies (now an EJC affiliate). In addition, Mr. Rawn has been president of the California Water Works Association and of the Federation of Sewage Works Associations.

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# Award of ASCE Prizes a Convention Feature

Once again the Society is awarding prizes for Transactions papers that are considered especially important. With the exception of the Construction Engineering Prize, which traditionally goes to an especially meritorious CIVIL ENGINEERING article, this year's awards honor papers appearing in Volume 122 (1957) of Transactions. The awards were announced by the Board of Direction at its Portland meeting, and they will be presented at the Wednesday morning ceremonies during the forthcoming Annual Convention in New York.

### Norman Medal

This year the Norman Medal, oldest and most distinguished of the Society's awards, is shared by two members of the University of Illinois civil engineering faculty—**Anestis S. Veletsos**, J.M. ASCE, and **Nathan M. Newmark**, M. ASCE—for their paper on "Natural Frequencies of Continuous Flexural Members." A 1948 graduate of Robert College (Istanbul), **Dr. Veletsos** received his M.S. and Ph.D. degrees from the University of Illi-

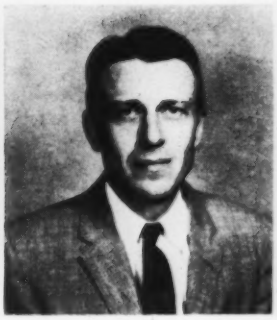
**ANESTIS S. VELETSOS**

**NATHAN M. NEWMARK**

**Co-winners of Norman Medal**

WILLIAM J. OSWALD HAROLD B. GOTAAS

Co-winners of J. James R. Croes Medal



CHARLES I. MANSUR ROBERT I. KAUFMAN

Co-winners of Thomas Fitch Rowland Prize

nois. He taught part time while pursuing his graduate studies, and since 1953 has been associate professor of civil engineering. He has served on a number of ASCE technical committees and is author of seven papers on structural engineering topics. **Dr. Newmark** has been on the university staff since 1930, and is now professor of civil engineering and head of the department. He has been in charge of the Structural Research Laboratory since 1946, and is author of over a hundred papers on structural analysis and design and applied mechanics. He is also widely known as a consultant to industrial organizations, government agencies, and the Armed Services. Dr. Newmark is no stranger to ASCE prizes, having received the J. James R. Croes Medal in 1945 and the Moisseiff Award in 1950.

## J. James R. Croes Medal

There were also two collaborators on the paper on "Photosynthesis in Sewage Treatment," which has been awarded the J. James R. Croes Medal, second of the Society's awards in point of distinction. They are **William J. Oswald,** A.M. ASCE, assistant professor of sanitary engineering at the University of California, and **Harold B. Gotaas,** M. ASCE, dean of the Technological Institute at Northwestern University. **Dr. Oswald** is also assistant research engineer at the University of California Sanitary Engineering Research Laboratory and author of many research papers on the biological aspects of sanitary engineering problems. During the war he served five years in the U. S. Army Medical Department. Before going to Northwestern University **Dr. Gotaas** was professor and chairman of civil engineering and director of the Sanitary Engineering Research Laboratory at the University of California.

He has also been chief engineer and president of the Institute of Inter-American Affairs responsible for technical development work in Latin America. In addition, Dr. Gotaas is well known as a consultant.

## Thomas Fitch Rowland Prize

The paper winning the Thomas Fitch Rowland Prize is another cooperative effort—the joint work of **Charles I. Mansur,** M. ASCE, and **Robert I. Kaufman,** J.M. ASCE. Their subject was "Underseepage, Mississippi River Levees, St. Louis District." **Mr. Mansur** is chief engineer of Luhr Brothers, Inc., a general contracting firm with headquarters at Columbia, Ill. He has had broad experience in the fields of sanitary engineering and soil mechanics and foundation engineering, both as an officer in the U. S. Public Health Service and the Army Corps of Engineers. He has been with the Waterways Experiment Station in a variety of research capacities, and until recently was chief of the Geology, Soils, and Materials Branch of the Mississippi River Commission. **Mr. Kaufman** has been in the Waterways Experiment Station since 1949, and now holds the position of chief of the Geology, Soils, and Materials Branch of the Mississippi River Commission recently vacated by Mr. Mansur. He is a graduate of Purdue University and has taught there.

## James Laurie Prize

**Chesley J. Posey,** M. ASCE, head of the department of civil engineering at the State University of Iowa and consultant to the Institute of Hydraulic Research there, is the winner of the James Laurie Prize for a paper entitled, "Flood-Erosion Protection for Highway Fills." Professor Posey's experience before joining the University of Iowa staff was with Modjeski and Chase and the American Bridge Company. He is co-author, with the late Sherman Woodward, Hon. M. ASCE, of *Hydraulics of Steady Flow in Open Channels* and author of a number of technical papers.

## Arthur M. Wellington Prize

This year's winner of the Arthur M. Wellington Prize is **Hamilton Gray,** M. ASCE, professor and chairman of the civil engineering department at Ohio State University, honored for his paper on "Field Vane Shear Tests of Sensitive Cohesive Soils." Before going to Ohio State in 1955 Professor Gray was for a decade professor of civil engineering at the University of Maine and soils engineer for the Maine Highway Commission. He has also taught at New York University and been a civil engineering assistant in the Harvard Graduate School. A consulting engineer of note, he has advised on the Maine Turnpike and the Portland Airport, among other projects.

## Collingwood Prize for Junior Members

**Turgut Sarpkaya,** A.M. ASCE, recipient of the Collingwood Prize for Junior Members, is assistant professor of engineering mechanics at the University of Nebraska. He is being honored for a paper on "Oscillatory Gravity Waves in Flowing Water," written while he was a Junior Member. He holds an M.S. degree in civil engineering from the Technical University of Istanbul and a Ph.D. degree in engineering mechanics and hydraulics from the State University of Iowa. He has been research engineer at the M.I.T. Hydrodynamics Laboratory, lecturer at the University of Paris, and chief research engineer for the State Hydraulics Works of Turkey.

## Rudolph Hering Medal

The Paper on "Photosynthesis in Sewage Treatment," awarded the J. James R. Croes Medal, has the additional distinction of winning the Rudolph Hering

CHESLEY J. POSEY
James Laurie Prize

HAMILTON GRAY
Arthur M. Wellington Prize

TURGUT SARPKAYA
Collingwood Prize for Juniors

Medal, which is awarded for a paper best contributing "to the advancement of the sanitary branch of the engineering profession." Authors **William Oswald** and **Harold Gotaas** are doubly honored.

### Ernest E. Howard

**Dr. Newmark,** co-winner of the Norman Medal, is also the winner of the Ernest E. Howard Award, endowed in 1954 in memory of ASCE Past-President Ernest E. Howard. The award is given annually to a member who has made a definite contribution to the advancement of structural engineering. Dr. Newmark is cited for "his contributions in the field of structural analysis and design as well as his specific contribution to the advancement of structural engineering in the aseismic design of the Latino Americana Tower in Mexico City."

### Thomas A. Middlebrooks Award

This year the Thomas A. Middlebrooks Award goes to **H. Bolton Seed** and **Lyman C. Reese,** Associate Members ASCE, for their paper entitled "The Action of Soft Clay Along Friction Piles." Holder of engineering degrees from the University of London and Harvard University, **Dr. Seed** was instructor in the Harvard Graduate School of Engineering in 1948 and 1949. He has been on the University of California engineering faculty since 1950, and is now assistant professor in the Engineering Materials Laboratory. He is author of a number of papers on soil mechanics subjects. **Dr. Reese** is an associate professor of civil engineering at the University of Texas, where he has been on the engineering faculty since 1955. Before that he taught for three years at Mississippi State College. He has also been consultant to a number of companies on problems involved in the erection of oil-drilling platforms in the Gulf of Mexico.

### Rickey Medal

**William F. Uhl,** M. ASCE, chairman of the Board of Directors of Charles T. Main, Boston, will receive the Rickey Medal for contributing "in an important manner to the science or progress of hydroelectric engineering." A specialist in hydroelectric power plant design and construction, Mr. Uhl has directed the building of over fifty important hydro plants. He has been manager of the hydraulic department of Allis-Chalmers, president of Charles T. Main, and senior partner in Uhl, Hall & Rich. He has been special consultant to the Corps of Engineers and a member of the Board of Consultants to the Tennessee Valley Authority.

### Moisseiff Award

Three engineers on the University of Illinois engineering staff had a hand in the paper on "Lateral Buckling of Elastically End-Restrained I-Beams" that wins the Moisseiff Award. They are **Walter J. Austin,** A.M. ASCE, **Shahen Yegian,** and **Tie P. Tung. Dr. Austin,** a graduate of Rice Institute with graduate degrees from the University of Illinois, has been on the Illinois research and teaching staff since 1946—at present as associate professor of civil engineering. **Dr. Yegian,** an alumnus of the University of Tehran in Iran, did graduate work at the University of Illinois, receiving his engineering doctorate in 1956. **Dr. Tung,** a graduate of Chiao Tung University in China, first came to the United States to work on the Joint Highway Research Project at Pur-

H. BOLTON SEED

LYMAN C. REESE

Co-winners Thomas A. Middlebrooks Award

WILLIAM F. UHL
Rickey Medal

WALTER J. AUSTIN

SHAHEN YEGIAN

Co-winners of Moisseiff Award

FREDERICK L. HOTES

J. C. Stevens Award

MYERS VAN BUREN

Construction Engineering Prize

due University. He then went to the University of Illinois to obtain his engineering doctorate and teach.

### J. C. Stevens Award

The J. C. Stevens Award for the best discussion of a Transactions paper goes to **Frederick L. Hotes,** M. ASCE, for his discussion of the paper, "Ground-Water Development—Basin Recharge." An engineering graduate of the University of Washington, with an M.S. from the State University of Iowa, Mr. Hotes has been employed since February 1957 as water conservation engineer in Iran for the Development and Resources Corporation of New York City. From 1947 to 1957 he was associate professor of civil and irrigation engineering at the University of California in Berkeley.

### Construction Engineering Prize

The Construction Engineering Prize is in a different category from the other ASCE prizes, being awarded for the best scientific or technical article on construction printed in CIVIL ENGINEERING. This year's recipient, **Myers Van Buren,** M. ASCE, is honored for an article in the February 1957 issue, entitled "Concrete Bridge Across Lake Pontchartrain Completed in Record Time." A 1938 graduate of Northeastern University, Mr. Van Buren has been with Raymond International Inc. (formerly the Raymond Concrete Pile Co.) since 1939. From 1943 to 1952 he was a research engineer on the development of the Raymond Prestressed Concrete Cylinder Pile, and since 1952 he has been assigned to the promotion and installation of the pile. He was a consultant on cylinder pile installation to the contractors on the Lake Pontchartrain causeway.

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## Tellers Canvass Ballot for 1959 Officers

*New York 18, N. Y.*
*September 16, 1958*

*To the 1958 Annual Meeting*
*American Society of Civil Engineers:*

The Tellers appointed to count the Election Ballots for officers of the Society for 1959 report as follows:

*For President*
(Term October 1958—October 1959)

| | |
|---|---|
| Francis de Sales Friel | 12,403 |
| Scattering | 126 |
| Void | 7 |

*For Vice President—Zone II*
(Term October 1958—October 1960)

| | |
|---|---|
| Paul Leach Holland | 2,732 |
| Scattering | 36 |
| Void | 1 |

*For Vice President—Zone III*
(Term October 1958—October 1960)

| | |
|---|---|
| Lloyd Dunaway Knapp | 2,338 |
| Ernest Wilson Carlton | 1,352 |
| Scattering | 1 |
| Void | 25 |

*For Director—District 1*
(Term October 1958—October 1961)

| | |
|---|---|
| Thomas Joseph Fratar | 999 |
| Elmer Knowles Timby | 989 |
| Scattering | 2 |
| Void | 16 |

*For Director—District 3*
(Term October 1958—October 1961)

| | |
|---|---|
| Earl Francis O'Brien | 399 |
| Scattering | 4 |
| Void | 0 |

*For Director—District 5*
(Term October 1958—October 1961)

| | |
|---|---|
| Daniel Brainerd Ventres | 262 |
| Waldo Edward Smith | 255 |
| Scattering | 0 |
| Void | 18 |

*For Director—District 7*
(Term October 1958—October 1961)

| | |
|---|---|
| Charles Wesley Britzius | 770 |
| Scattering | 6 |
| Void | 1 |

*For Director—District 11*
(Term October 1958—October 1961)

| | |
|---|---|
| Wayne Gilder O'Harra | 1,850 |
| Scattering | 6 |
| Void | 1 |

*For Director—District 12*
(Term October 1958—October 1961)

| | |
|---|---|
| Fred Harold Rhodes, Jr. | 780 |
| Scattering | 6 |
| Void | 0 |

*For Director—District 16*
(Term October 1958—October 1961)

| | |
|---|---|
| Nathan Thomas Veatch | 909 |
| Scattering | 8 |
| Void | 1 |

| | |
|---|---|
| Ballots Counted | 26,303 |
| Ballot Envelopes rejected: | |
| Without signature | 107 |

*Respectfully submitted,*
ROBERT W. RICHARDS, *Chairman*
ROBERT C. JOHNSTON, *Vice Chairman*

| | |
|---|---|
| E. L. Antoniazzi | T. K. A. Hendrick |
| N. H. Bettigole | S. J. Johnson |
| C. W. Buttz | R. C. Miller |
| J. H. Fisk | R. G. Newman |
| F. H. Hapgood | |

*Tellers*

## SOCIETY AWARDS AND FELLOWSHIPS AVAILABLE

**DANIEL W. MEAD PRIZES:** *1959 contest closes May, 1, 1959. See 1958 Official Register, page 134; September 1958 issue of CIVIL ENGINEERING, page 78.*

**FREEMAN FELLOWSHIP:** *1959-1960 award closes May 1, 1959. See Official Register, page 144.*

**ERNEST E. HOWARD AWARD:** *1959 award closes May 1, 1959. See Official Register, page 133; September 1958 issue of CIVIL ENGINEERING, page 80.*

## New Constituent Society For Engineers Joint Council

Engineers Joint Council has just admitted the American Institute of Industrial Engineers to constituent membership. In recent months three other societies have become affiliate members of EJC. They are the Western Society of Engineers, the Engineering Societies of New England, and the Louisiana Engineering Society.

The EJC roster now includes eleven constituent societies, two associate societies, and four affiliate societies—a total of seventeen member bodies.

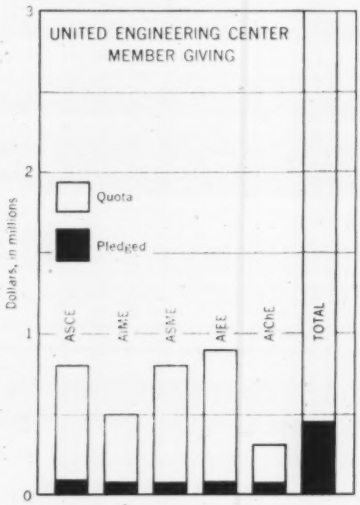
By the way, it is now Engineers Joint Council, Inc. Acceptance of the Articles of Incorporation, granted EJC by the Secretary of State of New York in March, was recently voted by the majority of the member societies of EJC.

# Why the United Engineering Center Is Important to You

**W. W. MOORE, M. ASCE**
**President, San Francisco Section**

The construction of an impressive engineering building on United Nations Plaza in New York City will focus the interest of millions of people on engineering. Many of these people do not know what engineering is, nor what it does for them. The proposed United Engineering Center will be a startling stroke of public relations. It will help bring the engineering profession to the attention of many people, and will further a recognition of the worth of engineering to the life of our times. The proposed location, facing the United Nations Headquarters, will emphasize the importance of engineering and the basic necessity of engineering services in all efforts to improve the lives of the people of the world. The public relations value of the Center will not be confined to the construction and opening of this fine facility—the desirable public relations and informational activities will continue for years. These activities will be facilitated and made more effective by the existence of a center from which professional activities will be coordinated.

The construction of the United Engineering Center will be a large step toward unity within the engineering profession. Much has been said about the advantages to be gained by unifying engineering organizations and coordinating their activities. It seems evident that centralizing the headquarters offices of the major Engineering Societies will result in better interchange of ideas, coordination of policies and programs and, ultimately, will be a large factor in bringing about effective unity within the profession. These factors will have direct bearing on the professional standing, popular recognition and financial rewards of the engineering profession, and of engineers as individual members of the profession.




**Status of member giving as of September 12.**

As with all similar activities, those who expect immediate, tangible results for their investment in this project will be disappointed. However, those who feel that the profession has offered them a stimulating and rewarding opportunity to make a living for themselves and their families, while contributing to the welfare of their fellow men, will feel that this further enhancement of their profession in the interests of those who will follow in future years is an obligation which they will wish to accept enthusiastically.

We engineers frequently expect that our efforts should be recognized by all elements of business, governmental and lay public, simply on the basis of the inherent merit of our works. Much favorable recognition and appreciation has been encouraged by public relations activities of government, business and industry. These activities include well planned and financed publicity and public educational programs and support of important research projects. In the United Engineering Center project, a major portion of the cost will be contributed by business and industry throughout the country. The entire project has been conceived and developed to promise desirable and long lasting benefits for the profession to which we devote our life and energy. With such support from others, the engineering profession must not fall short of supporting its own appropriate share of this activity.

[*Reprinted from the September issue of "The Civil Engineer," published monthly by the San Francisco Section.*]

## ASCE Giving for UEC Passes $100,000 as of September 12

| Local Section | Quota | Amount Pledged | % Quota |
|---|---|---|---|
| ZONE I | $197,300 | $ 45,962 | 23 |
| Dist. 1 | 133,300 | 41,807 | 31 |
| Brazil | 2,100 | ..... | .. |
| Metropolitan | 119,200 | 41,807 | 35 |
| Panama | 1,300 | ..... | .. |
| Puerto Rico | 3,100 | ..... | .. |
| Rep. Colombia | 2,400 | ..... | .. |
| Venezuelan | 5,200 | ..... | .. |
| Dist. 2 | 43,400 | 1,350 | 3 |
| Connecticut | 11,900 | ..... | .. |
| Maine | 4,700 | 150 | 3 |
| Massachusetts | 23,000 | 1,000 | 4 |
| New Hampshire | 1,800 | 100 | 6 |
| Rhode Island | 2,900 | 100 | 4 |
| Dist. 3 | 20,600 | 2,805 | 14 |
| Buffalo | 4,400 | 1,200 | 27 |
| Ithaca | 2,400 | 15 | 1 |
| Mohawk-Hudson | 7,500 | 1,570 | 21 |
| Rochester | 1,900 | ..... | .. |
| Syracuse | 4,400 | 20 | 1 |
| ZONE II | 169,700 | 22,453 | 13 |
| Dist. 4 | 34,600 | 15,326 | 45 |
| Delaware | 4,100 | ..... | .. |
| Lehigh Valley | 4,200 | 2,605 | 62 |
| Philadelphia | 20,000 | 11,671 | 58 |
| Central Pa. | 5,700 | 1,050 | 18 |
| Dist. 5 | 27,000 | ..... | .. |
| Nat'l Capital | 27,000 | ..... | .. |
| Dist. 6 | 49,000 | 3,827 | 8 |
| Maryland | 15,000 | 2,300 | 15 |
| Pittsburgh | 17,000 | 677 | 4 |
| Virginia | 13,300 | 850 | 6 |
| West Virginia | 3,700 | ..... | .. |
| Dist. 10 | 59,700 | 3,300 | 6 |
| Alabama | 8,900 | 566 | 6 |
| Florida | 11,500 | 210 | 2 |
| Georgia | 11,000 | 1,790 | 16 |
| Miami | 5,200 | 75 | 1 |
| Nashville | 2,700 | ..... | .. |
| N. Carolina | 6,300 | ..... | .. |
| S. Carolina | 4,900 | 345 | 7 |
| Tenn. Valley | 9,200 | 320 | 4 |
| ZONE III | 202,200 | 18,034 | 9 |
| Dist. 7 | 39,900 | 850 | 2 |
| Duluth | 1,500 | ..... | .. |
| Michigan | 18,000 | 250 | 1 |
| Northwestern | 8,000 | ..... | .. |
| Wisconsin | 10,700 | 600 | 6 |
| So. Dakota | 1,700 | ..... | .. |
| Dist. 8 | $37,100 | $ 2,700 | 7 |
| Cent. Ill. | 6,500 | ..... | .. |
| Illinois | 29,000 | 2,700 | 9 |
| Tri-City | 1,600 | ..... | .. |
| Dist. 9 | 45,700 | 5,906 | 13 |
| Akron | 3,100 | ..... | .. |
| Central Ohio | 5,100 | ..... | .. |
| Cincinnati | 4,700 | 540 | 12 |
| Cleveland | 9,300 | 220 | 2 |
| Dayton | 3,300 | ..... | .. |
| Indiana | 11,000 | 806 | 7 |
| Kentucky | 6,100 | 4,440 | 73 |
| Toledo | 3,100 | ..... | .. |
| Dist. 14 | 31,500 | 6,745 | 21 |
| Mid-Missouri | 3,500 | 350 | 10 |
| Mid-South | 11,000 | 2,605 | 24 |
| Oklahoma | 6,900 | ..... | .. |
| St. Louis | 10,100 | 3,790 | 37 |
| Dist. 16 | 48,000 | 1,833 | 4 |
| Colorado | 13,900 | 593 | 4 |
| Iowa | 5,900 | 210 | 4 |
| Kansas City | 12,000 | 1,000 | 8 |
| Kansas | 7,600 | ..... | .. |
| Nebraska | 6,300 | 30 | 1 |
| Wyoming | 2,300 | ..... | .. |
| ZONE IV | 230,800 | 16,963 | 7 |
| Dist. 11 | 132,600 | 16,475 | 12 |
| Arizona | 5,000 | 525 | 11 |
| Hawaii | 6,300 | ..... | .. |
| Intermountain | 4,700 | ..... | .. |
| Los Angeles | 50,200 | 3,305 | 7 |
| Sacramento | 16,300 | 100 | 1 |
| San Diego | 6,000 | ..... | .. |
| San Francisco | 44,100 | 12,545 | 28 |
| Dist. 12 | 40,400 | 188 | 1 |
| Alaska | 2,200 | ..... | .. |
| Columbia | 2,200 | 150 | 7 |
| Montana | 3,300 | ..... | .. |
| Oregon | 10,900 | ..... | .. |
| Seattle | 12,200 | ..... | .. |
| S. Idaho | 2,300 | ..... | .. |
| Spokane | 3,100 | 38 | 1 |
| Tacoma | 4,200 | ..... | .. |
| Dist. 15 | 57,800 | 300 | 1 |
| Louisiana | 13,000 | ..... | .. |
| Mexico | 1,400 | ..... | .. |
| New Mexico | 4,000 | ..... | .. |
| Texas | 39,400 | 300 | 1 |
| | $800,000 | $103,512 | 13% |

### TABLE I. Pledges to UEC as of September 12

| Society | Goal in Dollars | No. of Subscribers | Amount Pledged | % of Goal |
|---|---|---|---|---|
| ASCE | 800,000 | 625 | 102,700 | 13 |
| AIME | 500,000 | 157 | 84,300 | 17 |
| ASME | 800,000 | 874 | 82,500 | 10 |
| AIEE | 900,000 | 1,343 | 86,900 | 10 |
| AIChE | 300,000 | 221 | 77,900 | 26 |
| Others | ——— | ——— | 18,300 | — |
| Total | 3,000,000 | 3,260 | 452,600 | 15 |
| Industry | 5,000,000 | 176 | 3,557,700 | 71 |
| Grand total | 8,000,000 | 3,436 | 4,010,300 | 50 |

## ASCE Honorary Member Charles Breed Dies

In the death of Charles B. Breed—in Camden, Me., on August 11—the Society lost an Honorary Member and the profession lost a distinguished engineering educator and consultant. Professor Breed's entire teaching career was identified with Massachusetts Institute of Technology, his alma mater. From 1906 until his retirement in 1945 he was professor of railroad and highway transportation, and for the last decade of this period he was dean of the civil engineering department. At the time of his retirement he was given the title of professor emeritus of civil engineering.

Charles B. Breed

Until 1950 Professor Breed also had a consulting practice, specializing in transportation economics. He did considerable work for public utility commissions and for municipalities and railroads on grade-crossing elimination problems. A writer of note, Professor Breed was co-author, with Prof. George Hosmer, of a celebrated text on surveying that has gone through successive revisions and served many generations of college students. He has also aided in the writing and editing of ASCE and AIME Manuals.

Long a member of the Society, Professor Breed was named Honorary Member in 1949. He served a term as ASCE Director from 1943 to 1945. Professor Breed was the third appointee to honorary membership in Chi Epsilon and one of only 22 ever elevated to this rank in the entire 36-year history of the organization.

## ASCE to Work with Scouts On Career Guidance

Providing the means for early exposure of youngsters to civil engineering as an aid in career selection is the aim of cooperative efforts in which ASCE and the Boy Scouts of America are now engaging. Preliminary conferences have been held by ASCE members and members of the headquarters staff with Boy Scout officials to discuss a cooperative program involving three areas of probable activity.

As an initial move, ASCE has offered its help in implementing proposals that a grouping of Boy Scout merit badges be placed in a category identified as "Engineering." This would involve a regrouping of certain of the present merit badges and the addition of others to make the "Engineering" group more comprehensive. The Scouts also have under consideration a proposal for a merit badge grouping identified as "Science."

A second possible area of cooperation now in the planning stage is a program of field trips to engineering projects for Explorer Scouts in the 15-17 age group. It is hoped that this pilot program contemplated by the Metropolitan Section in New York will serve as a pattern for similar Local Section-sponsored Boy Scout field trips in other parts of the country.

Recruitment of civil engineers as Boy Scout counselors at local level is the third area of cooperation being studied. Such counselors would serve as training aides for Boy Scouts taking examinations for advanced class ratings and merit badges. It is believed that with the increased emphasis being placed on engineering subjects, the need for professional engineering guidance will be correspondingly greater.

## U. S. Engineers Host to Congress on Large Dams

The Sixth International Congress on Large Dams, meeting in New York September 15 to 20, brought some 400 foreign engineers to meet with an equal number of Americans. Francis Friel, President-Elect of ASCE, headed the U. S. Committee on Large Dams, host to the international group. Gerald T. McCarthy, M.ASCE, of New York, is vice chairman, and Stewart E. Reimel, M. ASCE, is secretary-treasurer. Gail A. Hathaway, a Past President of ASCE, is president of the International Commission.

Formal agenda for the meeting covered discussion of four technical subjects designated as:

*Question 20*—"Heightening of existing dams including methods of constructing new dams in successive stages."

*Question 21*—"Observation of stresses and deformations in dams and in their foundations and abutments; and a comparison of these observations with computations and tests on small-scale models."

*Question 22*—"Compaction methods and moisture content for materials used in the construction of earth core and supporting fill for earth and rockfill dams."

*Question 23*—"Use of admixtures and pozzuolanic materials in concrete for dams and the influence of the finer sand particles."

In accord with custom, formal papers on each subject were distributed in advance and the meeting utilized for discussion. Sessions were conducted in French and English.

In opening the convention Mr. Friel, a Philadelphia consulting engineer, commented on the ease with which engineers from all over the world "talk shop" on water use and conservation, without insisting that all be of one mind on political philosophy.

Mr. Hathaway, consultant to the International Bank for Reconstruction and Development, challenged the large dam builders with the idea that they might discuss, at the year 3000 A.D. meeting, building a dam from Norway to Greenland to avert another Ice Age. Purpose of the project would be to control the ocean currents. It is certain that many huge dams will be built in many parts of the world as demands for energy multiply.

In welcoming the ICOLD group, New York's Mayor Wagner commented that the city has $1,100,000,000 invested in dams, tunnels and appurtenant works to supply 1.2 to 1.6 billion gallons of water per day to its 8,000,000 residents. Some of these have ranked as major engineering structures of their time.

Following the meeting in New York, the visiting engineers were offered a choice of three study tours of U. S. dams: a southeastern tour, featuring the Tennessee Valley; a midwestern tour covering the Upper Missouri; and a northwestern tour concentrating on dams on the Columbia River and its tributaries.

At the close of the conference J. F. Rebelo Pinto, of Portugal, was named president of ICOLD, succeeding Gail Hathaway. The six new vice-presidents are Francis Friel, of the United States; A. A. Borovoy, of the Soviet Union; Susuma Nagata of Japan; Pietro Frosini, of Italy; Milan Vercon, of Yugoslavia; and Hamed Suleiman, of the United Arab Republic.

The next International Conference on Large Dams, the Seventh, will be held in Rome in 1961.

**At the opening meeting of the Sixth International Congress on Large Dams W. A. Dexheimer, commissioner, U.S. Bureau of Reclamation, welcomes the visitors for the U.S. Government. From left to right are Claud E. Chouvez, A.M. ASCE, of France, secretary-general of ICOLD; Susumu Nagata of Japan, vice president of ICOLD; Georges Drouhin of Algeria, vice president of ICOLD; F. H. Zurmuhlen, M. ASCE, consulting engineer of New York; Mr. Dexheimer; Francis S. Friel, President-elect of ASCE, chairman of the U.S. Committee on Large Dams; Gail Hathaway, Past-President of ASCE, president of ICOLD; F. J. Rebelo Pinto of Portugal, vice president of ICOLD; and G. T. McCarthy, M. ASCE, vice president of the U.S. Committee.**

## World Power Conference Meets in Montreal

Preceding the Large Dams Congress many of the engineers had participated in the World Power Conference in Montreal Sept. 7-11. Conference theme was "Economic Trends in the Production, Transportation and Utilization of Fuel and Energy." Here also the formal papers in French or English were available in advance for discussion at the conference. For each source of energy—hydro, fossil fuel or nuclear—engineers from many parts of the world detailed future prospects and future economic comparison with other energy sources. Economics of transportation of fuels, and the end product, electricity, were featured in the discussion. Greater distances have become economical for both.

### ASCE QUARTERLY ENGINEERING SALARY INDEX

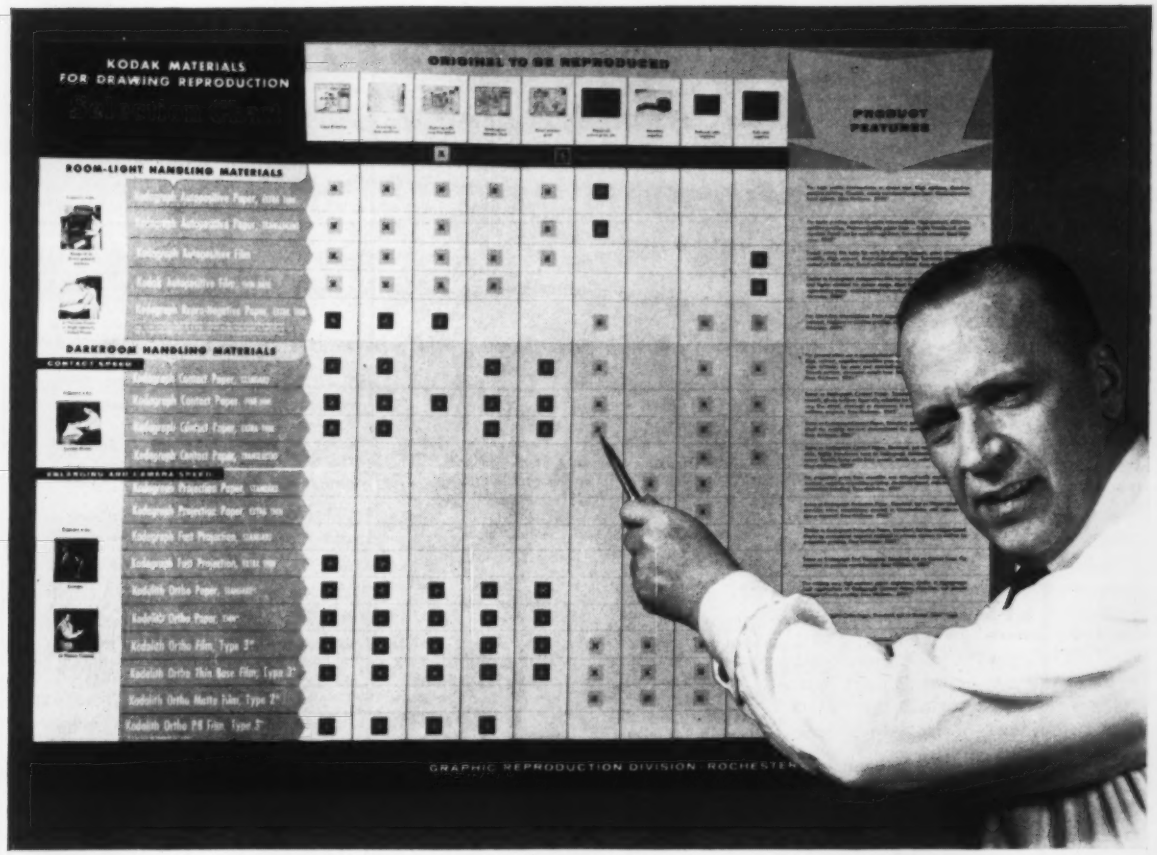
**Consulting Firms**

| City | Current | Last Quarter |
|---|---|---|
| Atlanta | 1.11 | 1.11 |
| Baltimore | 1.11 | 1.11 |
| Boston | 1.15 | 1.13 |
| Chicago | 1.30 | 1.26 |
| Denver | 1.22 | 1.19 |
| Houston | 1.12 | 1.08 |
| Kansas City | 1.14 | 1.14 |
| Los Angeles | 1.16 | 1.16 |
| New York | 1.20 | 1.17 |
| Pittsburgh | 1.05 | 0.94 |
| Portland (Ore.) | 1.15 | 1.15 |
| San Francisco | 1.19 | 1.17 |
| Seattle | 1.06 | 1.07 |

**Highway Departments**

| Region | Current | Last Quarter |
|---|---|---|
| I, New England | 0.91 | 0.85 |
| II, Mid. Atlantic | 1.17 | 1.17 |
| III, Mid. West | 1.25 | 1.15 |
| IV, South | 1.09 | 1.07 |
| V, West | 1.00 | 0.97 |
| VI, Far West | 1.15 | 1.15 |

Figures are based on salaries in effect as of May 15, 1958. Base figure, the sum of Federal Civil Service, G. S. Grades 5, 7, and 9 for 1956, is $15,930.




# Quick guide to better printmaking

**FREE** . . . this handy wall chart lets you put your finger right on the Kodagraph Reproduction Material which will give desired results in reproducing all types of drawings or other originals in all types of printmaking equipment.

Whether you do your own printmaking or order from a local blueprinter, you will find this chart a big help in the drafting room.

It tells you, for example, which Kodagraph Materials give you sharp, clean intermediate prints of old soiled drawings; which ones are best for reproducing blueprints, microfilm negatives, drawings with extremely fine detail.

In addition, this chart (printed on durable plasticized paper) brings you up to date on all the materials in the versatile Kodagraph and Kodalith lines. Saves you thumbing through pages of data books for information. *Well worth sending for today!*

**EASTMAN KODAK COMPANY**
**Graphic Reproduction Division, Rochester 4, N.Y.**

## Kodagraph Reproduction Materials

- **Kodagraph Autopositive Paper Extra Thin** for high-quality photographic intermediates at lowest cost.
- **Kodagraph Autopositive Paper Translucent** for faster printing, more durable, easier-to-revise intermediates.
- **Kodagraph Autopositive Film** for very fast-printing intermediates of highest quality.
- **Kodagraph Contact Paper Translucent** for fast-printing, durable, very high-quality intermediates.
- **Kodagraph Repro-Negative Paper** for black-line intermediates from negative-type originals.

Kodak
TRADE MARK

# The Younger Viewpoint

## The Voice of the Committee on Junior Member Publications

Greetings again to all with the younger viewpoint!

In an interesting conversation the other day with Bill Mulder, A.M. ASCE, of Clifton, N. J., he suggested that maybe some young thinking could be applied to solving the high rate of drop-out of Junior Members who are eligible for Associate Member status in ASCE. Why don't these civil engineers apply for higher status in their professional society? Is it the complexity of the application form? Is it the cost of transfer ($15 additional entrance fee plus $10 additional annual dues)? Or what? It does seem a shame that civil engineers voluntarily sever association with the prime group representing their interests in the professional world. Constructive advice and comments on this problem would be welcome.

The following letter was received on August 23, from Willard J. Sweeney, J.M. ASCE, Sanitary Engineer, Canal Zone:

"I am suggesting either of the following headings for the new Junior Member department:

"1. The Junior Journal

"2. Tidings of the ASCE Core

"The department will give me the opportunity to query my junior colleagues on a subject of recent interest—that is, personal relations. I am curious to know if others agree that more of our universities ought to add some formal instruction to their engineering curriculums concerning personal relations in engineering. This instruction might also include ethics, goals, associations, and the many related items which together help mold the personal character of the engineer and provide professional guidance."

Committee Member Linzing has forwarded to us the following letter from Robert W. Cunny, J.M. ASCE, Vicksburg, Miss.:

"In the August 1958 issue of CIVIL ENGINEERING, Past-President Lockwood states that '. . . to speculate about EJC joining NSPE doesn't even make good nonsense,' and with this no one could seriously disagree. But then Mr. Lockwood goes on to state that NSPE should join EJC, and this prompts the question, 'Does that make good sense?'

"NSPE is a federation of state professional engineering societies which has for one of its purposes the representation of the interests of the engineering profession before legislative bodies. For the privilege of engaging in legislative activity, NSPE has accepted a 501-c-6 tax classification which is less favorable than the 501-c-3 tax classification now held by other member societies of EJC. If NSPE were to join EJC, and were to continue in its legislative activities, the other member societies of EJC would risk the substantial financial advantages they now enjoy . . .

"It is true that EJC currently has a 501-c-6 tax classification. However, the Board of the United Engineering Trustees has stated that only organizations possessing a 501-c-3 classification would be considered for occupancy in the new United Engineering Center. EJC, upon acceptance of constitutional changes by the member societies, plans to make application for 501-c-3 classification.

"Mr. Lockwood concludes his article by stating that '. . . it [is] possible for engineering to have a single coordinating agency, the name of which will become a recognized household expression like the American Medical Association and the American Bar Association.' It is interesting to note that both the AMA and ABA have 501-c-6 tax classification. It is of further interest to note that the medical and legal professions have other societies such as the American College of Surgeons and the American Bar Foundation which enjoy 501-c-3 classification. These other societies do not purport to represent the profession before the public. But the AMA and ABA, partly because of their freedom to engage in legislative activity, and partly because of their local and state level organization, speak loudly and forcefully for the promotion and protection of the interests of their professions.

"Does unity in the engineering profession mean that all engineering societies must be federated into one organization? Based on the precedents established by the medical and legal professions, the obvious answer to this question is, 'No.'

"For the most effective promotion of the interests of the engineering profession, it would seem that all engineers should support two types of societies. One should be a society responsible for technical progress in the specialty fields, and the other should be a society responsible for, and organized specifically for, the furtherance of the professional interests of all engineers. Membership in two types of societies may not appear to be unity for some, but if each society were to engage only in that activity for which each is best organized, unity of effort would be achieved."

Your committee is happy to note that word of this page and its potential is now spreading through the profession. This is largely due to splendid local ASCE publicity, such as Walt Linzing recently placed in the Illinois Section's "ASCE News."

Your editor is now learning about the many such local ASCE publications that communicate effectively with civil engineers. The Texas Section is to be complimented upon its excellent "The Texas Engineer." In the July 1958 issue of this splendid publication, the extensive Junior Member activities of the Section are outlined. These include heavy Section operational responsibility, a technical paper contest and fine Section endorsement of the Daniel Mead Prize contest. Prof. Herbert H. Bartel, Jr. seems to be one of the prime movers. What do we hear from Alaska?

You may want to think about a few words printed in the monthly paper put out by the Engineers' and Scientists of America. In an article headed "A Career as an Engineer . . . or a Stepping Stone to Management?" they write:

"Ask a doctor if the senior doctor handles the administrative aspects of the medical business and he is likely to first be surprised at the question and then answer, 'Why, we hire our administrators!' One of the rules of the American Medical Association is that no non-doctor may share in the profits resulting from the services of doctors. The practitioner is clearly the senior, the administrator is an auxiliary."

We are sorry to report that Zone I Member Harry Morgan has left the Zone

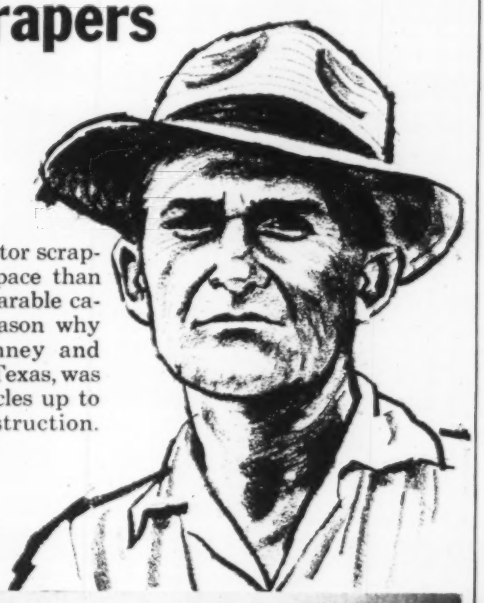
*(Continued on page 104)*

**Committee on Junior Member Publications**

**Milton Alpern, Chairman; 3536 Northview Ave., Wantagh, L. I., N. Y.**

| Zone I | Zone II | Zone III | Zone IV |
|---|---|---|---|
| Louis K. Walter, Jr.<br>320 Market Street<br>Kenilworth, N. J. | Raymond S. Gordon<br>State Planters<br>Bank Building<br>Richmond, Va. | Walter D. Linzing<br>4751 No. Pauline<br>Chicago 40, Ill. | Rodney P. Lundin<br>9744 Quakertown Ave.<br>Chatsworth, Calif. |

# Cuts cycle time 41% on watershed dams with Allis-Chalmers motor scrapers



Allis-Chalmers TS-260 motor scrapers turn around in less space than any other scraper of comparable capacity. That's one big reason why G. V. Walker of McKinney and Wheelock Co., Corsicana, Texas, was able to reduce hauling cycles up to 41 percent on dam construction. Here are the facts—

*G. V. Walker, Supt.*
*McKinney and Wheelock Co.*

These Allis-Chalmers TS-260 motor scrapers save 42 miles of extra travel for McKinney and Wheelock Co. on a Texas earthfill dam because of their ability to make full turns after the dam became too narrow for other scrapers to turn on.

## 3 earthfill dams . . . 300,000 cu yd moved

Superintendent Walker reports a total of 300,000 cu yd of material moved on three recent Texas watershed dam jobs. On these operations there were three Allis-Chalmers TS-260 motor scrapers. The shorter turning radius of the TS-260's (full turns in 30 ft) allowed Walker to build the dams higher before the scrapers were forced to travel the full length of the dam to turn around.

## Saves 42 miles of extra travel

On Project 26, for example, Walker's TS-260's were able to carry 162 more short-haul loads because they continued to make full turns after the dam became too narrow for other scrapers to turn. When the dam reached that critical height, other scrapers required a total haul-return distance of 550,800 ft. The distance traveled by the TS-260's totaled only 324,000 ft . . . saving 226,800 ft or 42 travel miles.

Loaded TS-260 powers its way upgrade to the rising dam.

Besides TS-260 turn-ability, Walker likes the positive, hydraulic, double-action bowl jacks that permit down pressure for fast penetration of hard material. The curved cutting edge breaks up sandy Texas clay, "boils" it into the bowl. Material loads easier and fills every corner for maximum yardage each trip. Positive forced ejection makes fast and accurate spreading.

All in all, G. V. Walker sees his Allis-Chalmers dirt-moving fleet as a real money-maker and work-saver. See for yourself by asking your Allis-Chalmers construction machinery dealer for an on-the-job demonstration. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

**Look ahead... *move ahead* ...and stay ahead with** **ALLIS-CHALMERS**

(Continued from page 102)

for a position as structures engineer with the Martin Co. at Orlando, Fla. However, excellent representation of Zone I will be taken up by Louis K. Walter, Jr. whose address is on our masthead.

Harry Morgan's resignation letter included the suggestion that we incorporate some young "wise" sayings in the paper. And with his illustrative example, we close this page:

"Men are like steel—they both lose value when they lose their temper."

# Division Doings

## Contrast of Floods and Droughts Dramatized at Hydraulics Conference

The perplexing irresponsibility of nature was the subject of intensive study during the recent ASCE Hydraulics Conference in Atlanta, Ga. During the three-day program the Hydraulics Division presented and received new information relating to man's control of surplus water and alleviation of shortages. Georgia Institute of Technology was the amphitheater for this presentation, August 20-22, with the Institute and the Georgia Section sharing sponsorship with the Hydraulics Division. The information presented forced the conclusion that something really can be done about the weather.

### First the Floods

Because floods are more dramatic than droughts and because we have had more experience with them, the subject of too much water came first on the program. Flood records were presented by four engineers: E. J. Williams reported for the Lower Mississippi Valley, Edwin W. Eden, Jr., for the Florida Everglades area, Reed A. Elliot for the TVA, and Nels C. Magnuson for the Wilmington District of the Corps of Engineers. With today's better records, engineers can plan better to do something about the floods. They are kept from doing so only by certain differences of opinion as to how much money should be spent, where it should be spent, and on what it should be spent. The new procedures for keeping the better records will be described in detail as the Atlanta papers are published.

What happens to the surplus water as it runs downhill to the sea or, in some cases, refuses to do so was also studied. Research has furnished some new answers in this area of concern. Philip H. Carrigan, Jr., hydraulic engineer for the U.S. Geological Survey at Atlanta, told about the behavior of flow through multi-opening constrictions in channels, such as multi-pier bridges which sometimes get washed out. Culverts and highway embankments also offer a challenge to flood waters. Herbert G. Bossy, of the Bureau of Public Roads, presented some new ideas on the first of these, and Prof. Carl E. Kindsvater, of Georgia Institute of Technology, on the second. As a speaker, Dr. Kindsvater was acting in a dual capacity, because he was also general program chairman.

As the flood waters scour away, they deposit the resulting sediment, and engineers would like to know where it will be deposited. Several papers suggested how to get at this problem. The scour at bridge crossings was studied by Prof. Emmett M. Laursen, at his laboratories in East Lansing, Mich. Professor Laursen told the conference about his work, and showed what happened with the aid of slides. Daryl B. Simons, project leader for the U.S. Geological Survey at Colorado State University, showed how to design stable channels. However, he has been working with streams that are much more predictable as, for instance, irrigation canals. What happens when a jet of water scours away was described by Yuichi Iwagaki, associate research engineer at Colorado State.

There are still problems when the water finally gets down to the sea. The Committee on Tidal Hydraulics took some new looks at the old problem of salinity, as at Vermillion bay in Louisiana, discussed by Hu B. Myers, chief engineer for the Louisiana Department of Public Works. The problem in other localities was discussed by M.I.T. Professors Arthur T. Ippen and Donald R. F. Harleman. A talk on hydraulic cycles at Southwest Pass on the Mississippi—by Prof. Chester A. Peyronnin, Jr., of Tulane University—rounded out the presentation.

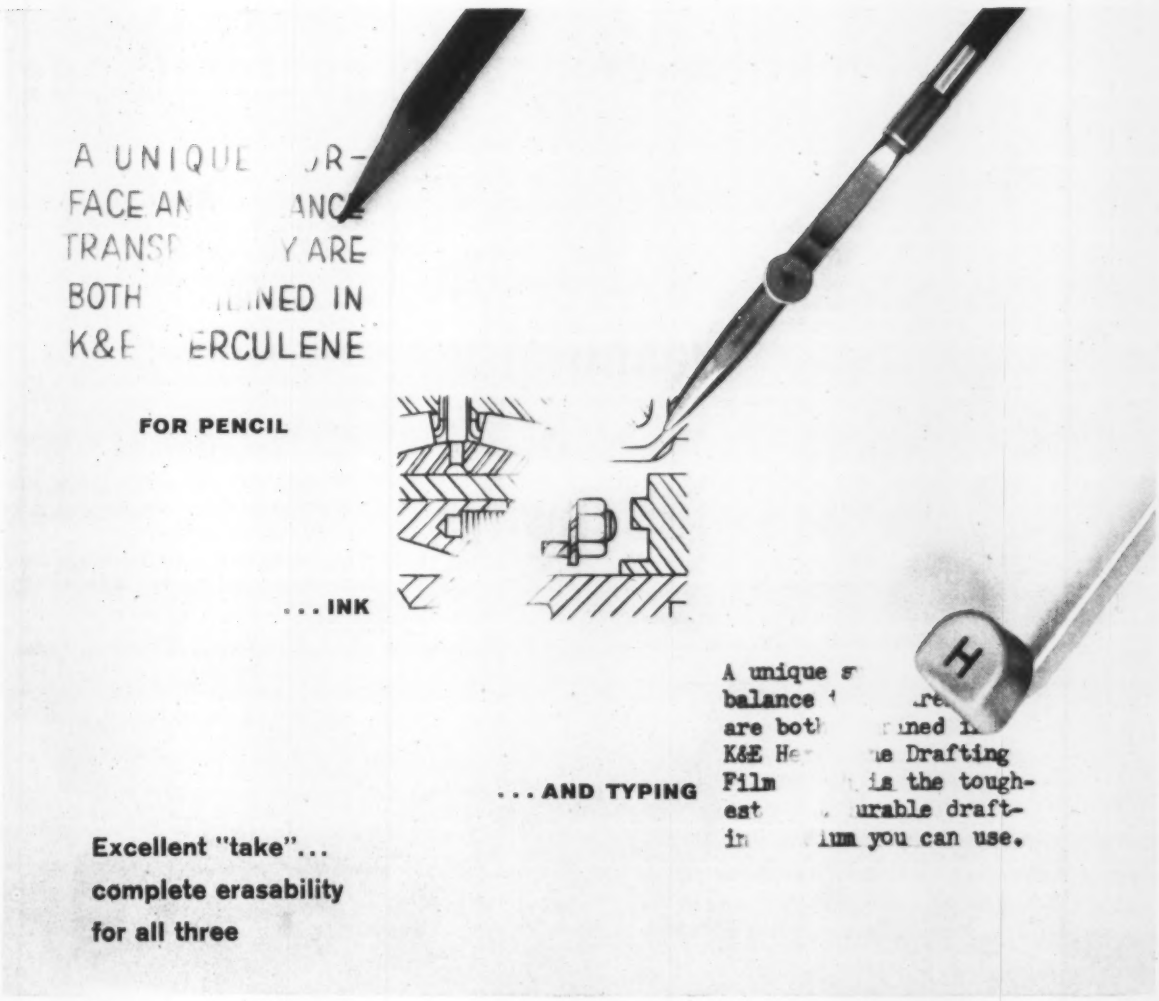
Dr. Ippen also had some ideas about how water flows in open channels, which aroused considerable interest and discussion. This was at another session devoted to the behavior of water when it flows, as in concrete pipes (discussed by Prof. Lorenz G. Straub), as in slugs or rolls (by Prof. Paul G. Mayer), as in rough conduits (by Prof. Henry M. Morris), or according to the "Colebrook-White Universal Resistance Relation" (as explained by Dr. Ippen).

**President Louis R. Howson discusses Hydraulics Conference program with the chairmen in charge of the successful event. Shown, in usual order, are M. T. Thomson, general conference chairman; H. M. Martin, Division chairman; and C. E. Kindsvater, program chairman. Mr. Howson addressed the conference banquet.**

### Then the Droughts

Water use—of very special importance in time of drought—also came in for active discussion. The panel-type presentation was moderated by Robert E.

(Continued on page 108)

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Company & Address: _____

_____

# Pressure-creosoted guardrail posts

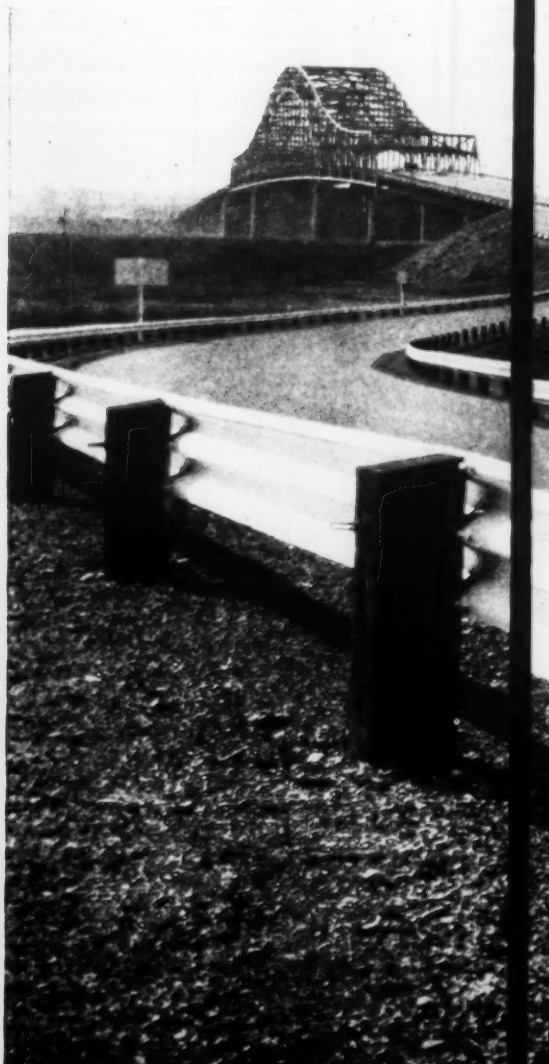
## On Washington State Highways

**This handsome guardrail installation** is on the Pasco approach of the Columbia River Bridge, U. S. Route 410, in Washington State. It includes 400 pressure-creosoted posts 8″ x 8″ square and 5′4″ long, supporting a 14-inch steel guardrail.

The contract was won with a low bid of $13,039 by Sather and Son of Yardley, Washington. Pressure-creosoted posts were selected because they were good-looking, had high resistance to impact and promised to save tax money for 18 or 20 years to come.

Installation costs were less because the men could handle the posts without

**Pressure-creosoted posts keep maintenance costs low on these guardrails and provide good protection and good looks, too.**



# last longer... save tax money

bringing in extra machines. Maintenance is low because the flexibility of the posts lessens the possibility of damage from impact, and pressure creosoting protects the posts from rot and wood-destroying insects.

The resident engineer, Mr. Lloyd H. Mackey, says that pressure-creosoted posts are used on a large percentage of the guardrail installations in his 1200 miles of territory. He has been on the job for 14 years and most of the creosoted posts installed before he came are still in use.

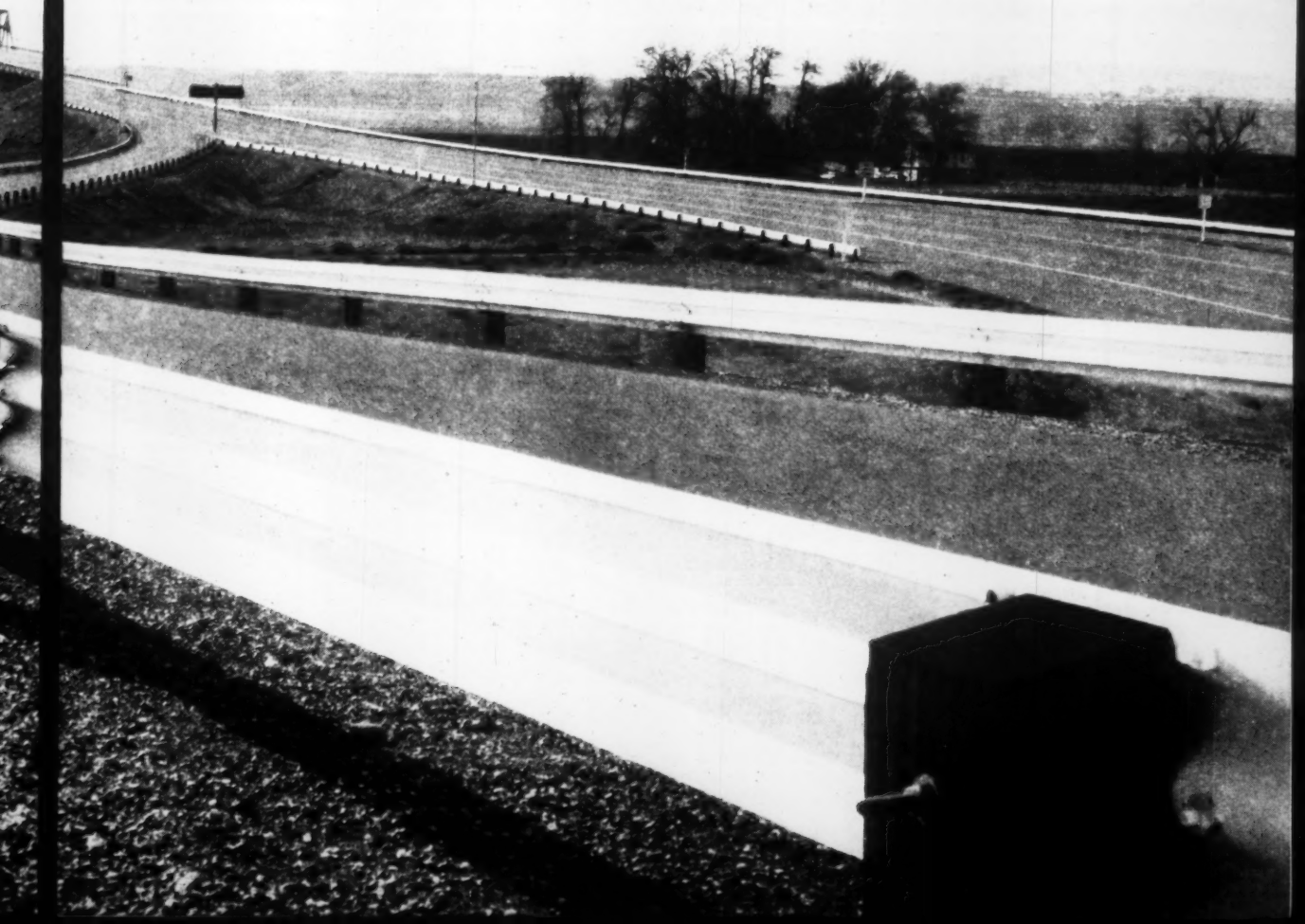
*This experience on the Washington State Highways verifies the results being obtained in other parts of the country. Pressure-creosoted posts make your tax dollars go further.*

**Note:** U. S. Steel does not make pressure-creosoted posts but supplies much of the creosote used by the wood-treating industry. For more information write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. *USS is a registered trademark*

*Creosote's Past Assures Wood's Future*

USS **Creosote**

Sales Offices: Pittsburgh, New York, Chicago, Salt Lake City and Fairfield, Alabama



(Continued from page 104)

Stiemke, director of civil engineering at Georgia Tech. The experts were Cecil W. Chapman, of the U. S. Department of Agriculture, who asked for more water for farming; T. M. Forbes, who wants more water for industry (he is executive vice-president of the Cotton Manufacturers' Association of Georgia); Dr. Stiemke, who stated the case for the utilities and municipalities; and Robert H. Marquis, a lawyer for the TVA, who explained how laws are getting into the situation. If any conclusion to the water-distribution problem was reached, it was that water could be used much more effectively if there were fewer pressure groups and more engineers seeking solutions to the problem.

### Sunshine for the Families

During all the talk of water the sun shone on the engineers and their families gathered for the conference. The pleasant social program was arranged by General Chairman Medford T. Thomson and Mrs. Thomson, who was co-chairman of women's activities; by Program Chairman Carl Kindsvater and Mrs. Kindsvater, the other co-chairman of the women's program; and by energetic committees of Georgia Section members. The high point of the social program was a banquet at which President Louis R. Howson urged the group to think about their community responsibilities, especially in situations where they are uniquely equipped to obtain the right answers to community problems. Dr. Edwin Harrison, president of the Institute, also addressed the banquet.

**Plans for the 1959 Hydraulics Conference are made during the Atlanta conference, as new conference officers learn the ropes from this year's officials. Here retiring chairmen Arno Lenz, Medford T. Thomson, C. E. Kindsvater and Arthur T. Ippen pass the torch to A. R. Chamberlain, M. E. Bender, Jr., and Maurice Albertson, all of Fort Collins, Colo., where the 1959 Conference will be held. (June 29-July 1 are the dates.)**

## ASCE CONVENTIONS

**ANNUAL CONVENTION**
New York, N. Y.
Hotel Statler
October 13-17, 1958

**LOS ANGELES CONVENTION**
Los Angeles, Calif.
Hotel Statler
February 9-13, 1959

**CLEVELAND CONVENTION**
Cleveland, Ohio
Hotel Cleveland
May 4-8, 1959

## TECHNICAL DIVISION MEETINGS

**CONFERENCE ON ELECTRONIC COMPUTATION**
Kansas City, Mo.
Continental Hotel
November 20-21
*Sponsored by*
ASCE Structural Division
Kansas City Section

**JET AIRPORT CONFERENCE**
Houston, Tex.
Shamrock-Hilton
May 20-22, 1959
*Sponsored by*
ASCE Air Transport Division
Houston Branch of Texas Section

## LOCAL SECTION MEETINGS

**Central Pennsylvania Section**—Dinner meeting at State College, Pa., on November 14 at 7 p.m.

**Los Angeles Section**—Dinner meeting of the Santa Barbara-Ventura Counties Branch at El Presidio Restaurant on October 21 at 7:30 p.m.; dinner meeting of the San Bernardino-Riverside Counties Branch at Mike's Grill on October 21 at 6:30 p.m.

**Massachusetts**—Joint meeting with the Boston Society of Civil Engineers and the New England district of the American Society for Testing Materials at the M.I.T. Faculty Club (50 Memorial Drive, Cambridge), October 30, at 5:30 p.m.

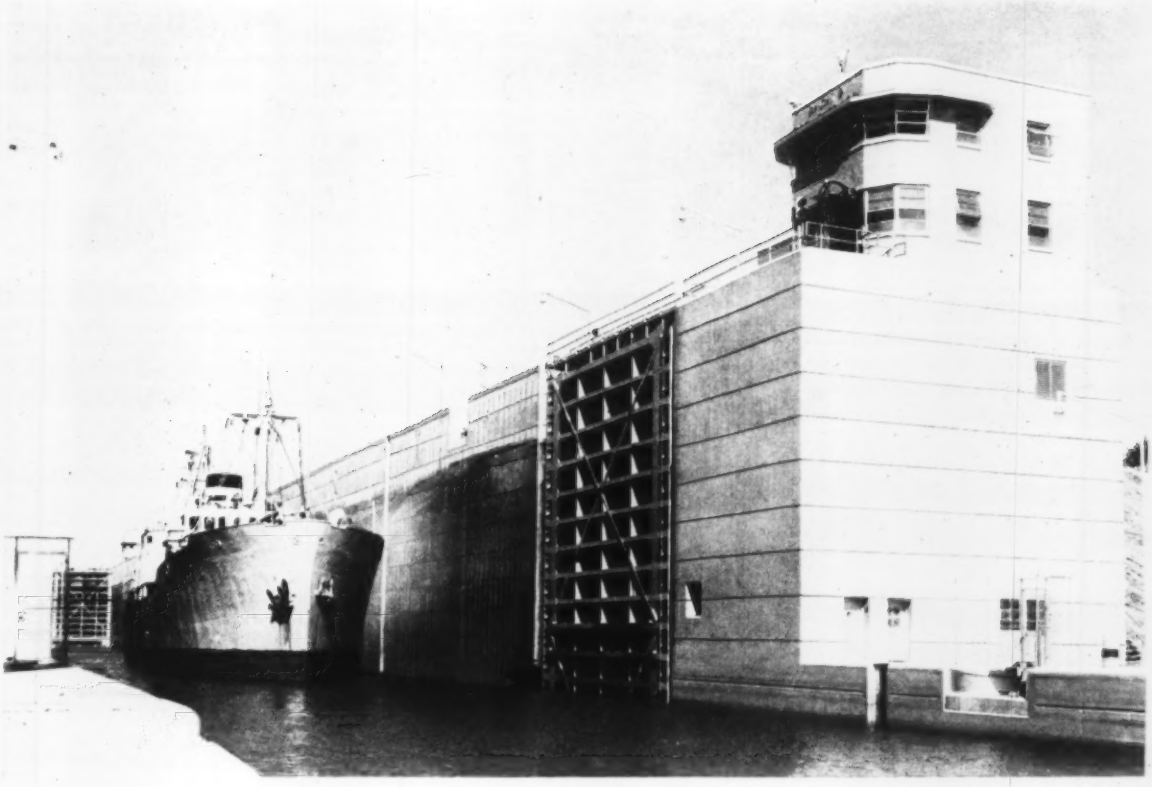
**Nebraska**—Dinner meeting at the Rome Hotel, Omaha, October 15, at 6:30 p.m.

**Sacramento**—Weekly luncheon meeting at the Elk's Temple every Tuesday at 12 noon.

**Texas Section**—Dinner meeting of the Houston Branch at the Engineering and Scientific Society of Houston on October 21 at 6:30 p.m.

### ASCE Membership as of September 9, 1958

| | |
|---|---|
| Members | 10,133 |
| Associate Members | 14,264 |
| Junior Members | 17,591 |
| Affiliates | 77 |
| Honorary Members | 46 |
| Total | 42,111 |
| (September 9, 1957 | 40,771) |



Dwight D. Eisenhower Lock, 800 ft. long and with concrete walls 100 ft. high, is one of the Seaway projects in which Lehigh Cements were used. Supervising Engrs.: U.S. Army Corps of Engrs. General Contractor: Morrison-Knudsen, Walsh, Perini.

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- Lehigh Early Strength Cement
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- Lehigh Air-Entraining Cement

3300 ft. long St. Lawrence Power Dam is world's second largest, producing 2.2 million H.P. of hydroelectric power. Masonry walls of this 10-story powerhouse, at American end of Dam, are laid up with Lehigh Mortar Cement. Consulting Engrs.: Uhl, Hall & Rich. General Contractor, U.S. Half: Perini, Walsh, Morrison-Knudsen, Kiewit, Utah.

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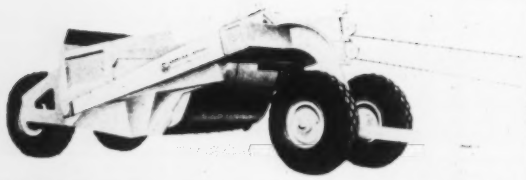

**MODEL CWT-8**

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**MODEL CW-27**

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**MODEL CWT-15**

15.0 cu. yds. STRUCK
21.0 cu. yds. HEAPED

**MODEL CW-215**

INTERCHANGEABLE WITH MODEL CWD-214 REAR DUMP UNIT

15.0 cu. yds. STRUCK
21.0 cu. yds. HEAPED

**MODEL CWT-20**

20.0 cu. yds. STRUCK
27.0 cu. yds. HEAPED

**MODEL CW-220**

INTERCHANGEABLE WITH MODEL CWD-221 REAR DUMP UNIT

20.0 cu. yds. STRUCK
27.0 cu. yds. HEAPED

**MODEL CWT-26**

26.0 cu. yds. STRUCK
33.0 cu. yds. HEAPED

**MODEL CW-226**

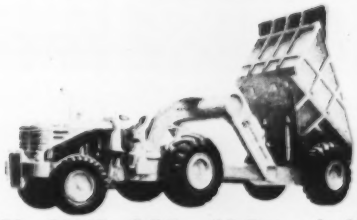
INTERCHANGEABLE WITH MODEL CWD-221 REAR DUMP UNIT

26.0 cu. yds. STRUCK
36.0 cu. yds. HEAPED

**MODEL CW-320**

INTERCHANGEABLE WITH MODEL CWD-321 REAR DUMP UNIT

20.0 cu. yds. STRUCK
27.0 cu. yds. HEAPED



**MODEL CWD-321**

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**SOUTH BEND DIVISION**
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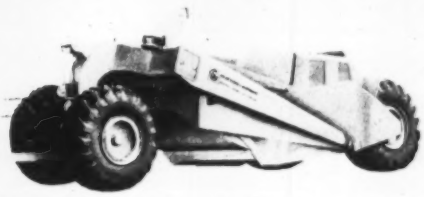
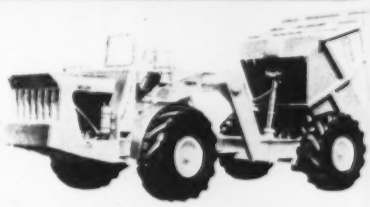


**MODEL CWT-30**

30.0 cu. yds. STRUCK
39.0 cu. yds. HEAPED



**MODEL CWD-214**

INTERCHANGEABLE WITH MODEL CW-215 SCRAPER UNIT

14.0 cu. yds. STRUCK
21.0 cu. yds. HEAPED
25-TON LOAD CAPACITY

# BY-LINE WASHINGTON . . . .

**The 85th Congress has been highly complimented** for an unusually productive session. In construction matters, too, the legislators debated some heavy financing programs and took decisive action on many. Here, briefly, are some of them:

*Highways* . . . Congress drafted and passed the Federal-Aid Highway Act of 1958, boosting authorizations for the Interstate System by $200 million annually and creating a special anti-recession program of $400 million for the ABC systems. Even more important, it rejected the Byrd amendment, which would have frozen apportionments to the states at the amount of actual revenues into the Highway Trust Fund, many millions of dollars below the billions authorized. Another act permits right-of-way acquisition seven years in advance of construction with the use of federal funds. The limitation has been five years heretofore.

*Atomic Energy* . . . the Joint Congressional Committee on Atomic Energy unveiled a $875-million program of power development aimed at making nuclear power as cheap as other sources by 1970. Construction of atomic plants (at a cost of about $500 per kilowatt) would take $500 million; research and design, another $375 million. Hearings will be held next fall.

*Airports* . . . Congress passed—and the President vetoed—an expanded program of federal aid for airport construction. Congress wanted to boost the level of grants (which are matched 50-50) from $63 million a year for the next four years to $100 million.

*Civil Works* . . . The legislators hammered out a billion-dollar civil works authorization measure to advance Corps of Engineers' and Bureau of Reclamation projects. Also, a $1.1 billion appropriaton act. President Eisenhower signed the latter somewhat reluctantly. He said it would advance 65 projects of nebulous value which would ultimately cost $700 million.

*Industrial Plants* . . . A new federal-aid scheme sauntered through the back door this session and was promptly invited to the dinner table. Congress approved a program of loans to build new industrial plants in areas suffering from chronic unemployment. Also part of the package, $75 million in grants for construction of public facilities which would make location of new plants in these areas more attractive.

*Military Construction* . . . Congressmen approved a $1.3-billion military construction bill. Of the total, $785 million goes to the Air Force, $295 million to the Navy, and $230 million to the Army.

*The Jenkins-Keogh bill, proposing tax relief* to self-employed engineers ground through the House late in the session, but there just wasn't enough time left for the long trip through the Senate. It died in the Finance Committee.

* * *

**The Army Corps of Engineers is going to continue** to insist that fixed-span highway bridges over the Atlantic Intercoastal Waterway be designed to give at least 80 ft of clearance. Highway engineers have been battling for a lowering of the rule to 55 ft, maintaining that too much consideration was being given to boat traffic at the expense of construction budgets. Lower structures with movable spans will be permitted, the Corps says, but road engineers point out that movable structures are prohibited on the other hand by Interstate System standards.

* * *

**Federal highway officials accepted** "half a loaf" as the Senate Subcommittee on Roads approved their cost estimate for the Interstate System for 1961 apportionments only. State engineers were warned to resist any temptation to load their construction cost estimates because Uncle Sam is putting up 90 percent of the money. Congress obviously intends to be looking over their shoulders.

*Federal Highway Administrator Bertram Tallamy did an excellent job* of explaining to the Senators how much "engineering judgment" figures in the estimate of highway development costs. And he appealed to the lawmakers not to expect uniformity from state to state in such design features as widths of right-of-way, shoulders, and median strips. These are elements which only a knowledge of local conditions can dictate, he said.

*Engineers are particularly fearful* of sporadic recommendations that *maximum* design standards as well as *minimum* be written for the Interstate System. The General Accounting Office, which investigated the cost-estimating methods of engineers in 11 key states, had already told Congress that if uniformity is the goal, engineers should be held to maximum design standards. It was this argument that both federal and state engineers tried hard to overcome.

* * *

**A penetrating study into highway department management** has just been completed by the Automotive Safety Foundation headquartered here in Washington. The ASF, which has distinguished itself with its highway-need studies for nearly 30 states, was called upon by the legislature and governor of Pennsylvania to appraise the administration of highway engineering in that state. The Foundation was bluntly critical of personnel practices which are preventing the state from building a corps of professional engineers. At the heart of the problem —politics.

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# NEWS BRIEFS . . .

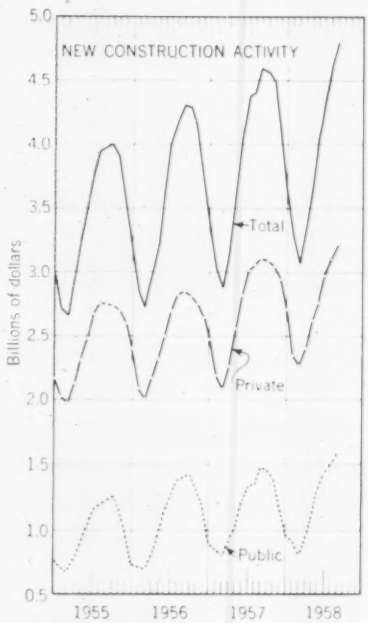
## Dollar Value of Construction Rises in August

The dollar value of new construction put in place rose seasonally in August to a record monthly high of $4.8 billion, 3 percent above August 1957, according to preliminary estimates of the U. S. Departments of Labor and Commerce. Outlays for the first eight months of 1958, at $31.5 billion, were up a little from the comparable 1957 period, but physical volume was probably about the same in both years.

The private total thus far in 1958, amounting to $21.9 billion, was off only slightly from the total for the same 1957 months, as the drop in industrial building was almost offset by gains in most other types of private work.

Outlays for publicly owned construction, totaling $9.7 billion, were 6 percent above a year ago, largely the result of continued expansion in highways and public housing projects. Federal funds (primarily grants-in-aid to states and localities) accounted for virtually all the over-the-year increase in the public total. State and local funds, which represent roughly 70 percent of public construction activities, amounted to about the same in both years.

These monthly estimates are determined primarily by past contract award movements, standard progress patterns, and assumed normal seasonal movements. Except when special surveys are made, the estimates do not reflect the effects of varying numbers of working days in different months, nor of special conditions influencing the volume of activity in any given month, such as unusual weather, materials shortages, overtime, work stoppages, and postponements.




**Seasonal rise in construction in August brings dollar value of construction for cumulative eight-month total to new high.**

## Arctic Construction Studied At Meteorological Meeting

Drifting snow, which is likely to permanently cover facilities and installations in the strategic polar regions, has been converted from a hazard to a useful tool, according to R. W. Gerdel, M. ASCE, a member of the Army's Snow, Ice and Permafrost Research Establishment. In a talk given at the Second Annual Conference on Applied Meteorology-Engineering—held at the University of Michigan early in September—Mr. Gerdel said that the snow can easily be collected by catchment fences and used to construct elevated roads, air strips, and hardstands on the polar ice caps, where practically no snow is lost by melting.

This technique, he said, would help solve the problem of the development of finger-drifts on rolled- or compacted-snow aircraft-landing strips, which are not visible to the pilot. "Frequently such drifts cause the collapse of the wheel carriage on one side of a landing aircraft, and some ski-equipped aircraft have been wrecked by drifts on prepared snow and ice runways. . . . On the high polar ice caps blowing and drifting snow is an almost continuous phenomena. With no alleviation by melting, as in the temperate zone, facilities not properly designed are quickly and permanently covered by drifts."

Much of the research on the problem, Mr. Gerdel said, has been carried out at Keewenaw, Mich., and in Greenland. He added that further research is still underway, including wind-tunnel investigations on the mechanics of drifting snow.

The three-day conference marked the first time that engineers and meteorologists have formally convened to consider problems of mutual interest. The sponsors were the American Meteorological Society, the University of Michigan Research Institute, and the university's Willow Run Laboratories. ASCE was represented in the formulation of the joint program by Prof. Robert H. Sherlock.

## Paraguay Pushes Road-Building Program

Paraguay is in the midst of a badly needed road-building boom, according to the International Road Federation. The country, which has long been connected with the rest of South America by only five all-weather roads, is now pushing important highway work, plus the construction of hotels and other tourist facilities. The spur to this activity is a $7,000,000 loan from the Export-Import Bank, made available from the sale of U. S. surplus agricultural supplies in Paraguay, and the efforts of a Paraguayan-Brazilian Joint Commission formed to encourage the building of transportation links between the two countries.

The two major highways under construction are (1) the Trans-Chaco Route, which will connect Asuncion, the capital, with Bolivia, at Fortin Oruro, on the border and (2) a route connecting Asuncion with Brazil, at Puerto Presidente Stroessner, on the Parana River. The Trans-Chaco Route will provide a link-up with the Pan-American Highway system. Work is underway on a 254-mile stretch of this project which will have a total length of 403 miles. The highway connecting with Brazil will be 202 miles long. An 81-mile section of this road is already finished, and completion of the entire project is set for February 1959. At the Parana River the highway will connect with a 1,735-ft bridge Brazil is building.

## New Approach System for George Washington Bridge

Work on the improved New York approach system to be built in connection with the $182,000,000 lower level of the George Washington Bridge will begin early this fall, the Port of New York Authority announces. A $1,717,370 contract for the project has been awarded to the low bidder, the Gull Contracting Company, of Flushing, N. Y. The expanded New York approach system will link both the upper and lower bridge levels with city streets and suburban parkways.

The second deck was authorized in July 1957 and will be ready for traffic in 1962. This summer the Bethlehem Steel Company received a $13,610,298 contract for the suspended structure, including the furnishing and erecting of 13,875 tons of structural steel. Steel erection from barges below the present bridge will begin early next year and be completed by December 1960.

Opened to traffic in 1931, the George Washington Bridge is the third longest suspension bridge in the world. Last year the eight-lane structure carried 35,810,014 vehicles. Addition of the six-lane lower level will increase its annual traffic capacity by 75 percent.

## Portland Dedicates New Airport Terminal Building

Opening of a new $5,825,000 jet-age terminal building at the Portland (Ore.) International Airport took place on September 8. In its initial stages the terminal is designed to handle a traffic volume of 1,000,000 passengers a year—a peak expected by 1963. The estimated 1958 traffic is 725,000 passengers. The nine-story, 500-ft-long terminal has 18 plane-loading positions, double the capacity of the previous facilities. The structure is designed for ultimate expansion of up to 34 plane-loading positions. It was two years in construction.

The prime contractor was the Ross B. Hammond Construction Company, and the architects were Burns, Baer, McNeil and Schneider, both of Portland. J. J. Winn, Jr., is general manager for the Port of Portland, developer and operator of the airport.

## New York Group to Aid Iran Development Project

A far-reaching program for modernizing and developing a 50,000-sq mile area of the Kerman Province in south central Iran has been launched by the Kerman Development Corporation of New York—a company formed for the purpose by the Electric Bond and Share Company and Allen & Company, New York investment bankers. Under the terms of a recent agreement between Iran's Plan Organization and the Kerman Corporation, technical and management skills for the project will be furnished by Ebasco and the necessary financial services by Allen & Company.

The proposed program for the area, which is comparable in size to New York State, will cover exhaustive studies of the resources and potential of the region with an eye to expanding its economy. The area is rich in natural resources—coal, lead, copper, iron, and bauxite, to mention a few—and one of Ebasco's primary responsibilities will be to advise the Plan Organization of ways to expedite the development of these resources. The program also includes improvement and expansion of electric power, communication, and transportation facilities and development of additional water resources for the area.

## Steel Production Rises in August

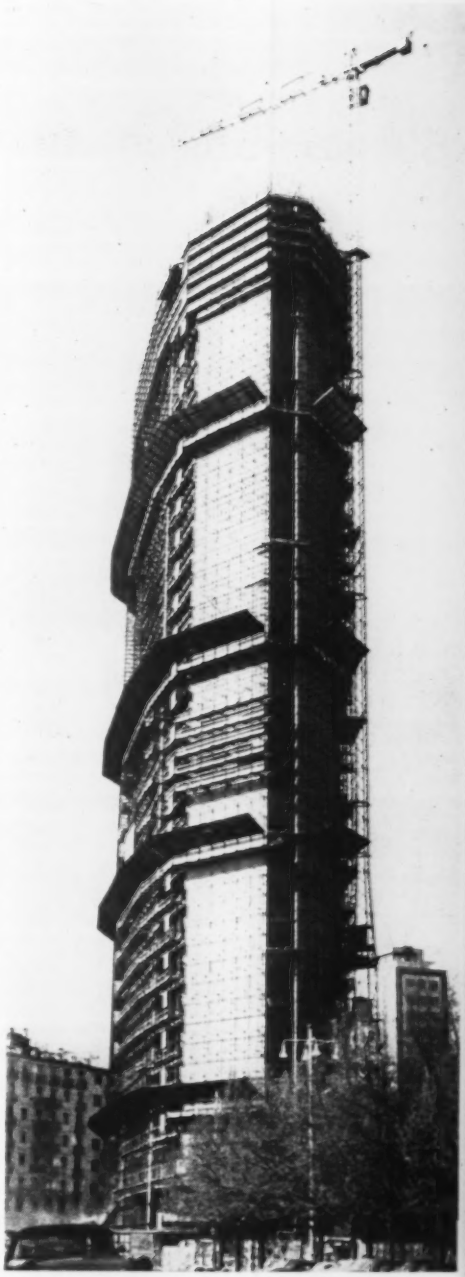
During August the nation's steelmaking furnaces produced 7,285,000 tons of ingots and steel for castings, the highest monthly output so far this year, the American Iron and Steel Institute reports. The total represented an increase over the July output of 6,420,405 tons, but was considerably below the August 1957 output of 9,233,890 tons. On the basis of the industry's annual capacity of 140,742,570 tons (as of January 1, 1958), the steel-making facilities this August were utilized at an average of 60.9 percent of capacity.

Steel production for the first eight months of this year was 51,457,892 tons. For the comparable part of 1957 the eight-month total was 78,726,169 tons.

## Artesian Wells Furnish Memphis Water Supply

Memphis, Tenn., is one of the largest cities in the world to obtain its entire public water supply from artesian wells. In 1955, according to a recent U. S. Geological Survey report, the city pumped about 60 mgd from its artesian aquifers known as the "500-foot" and the "1,400-foot" sands. Industries took about 70 mgd more. Water pumped from terrace deposits of sand and gravel, for domestic use and small industries, amounted to an additional several million gallons a day.

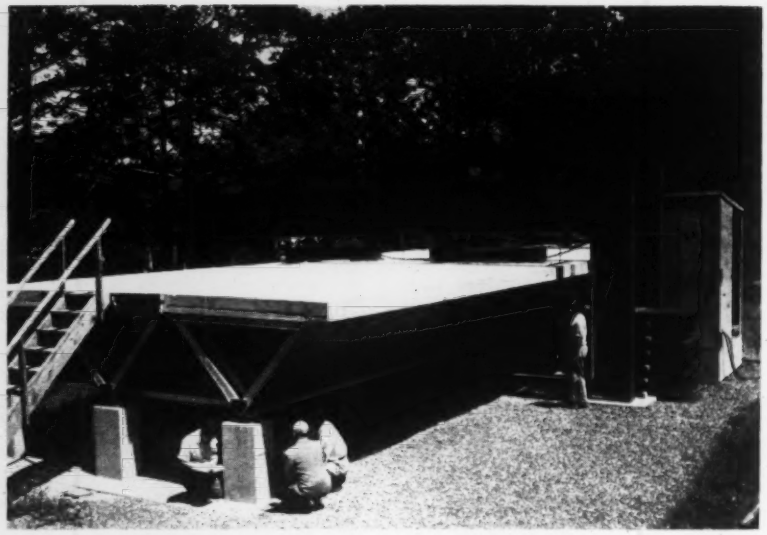
The water from the artesian sands is said to be of very good quality, except for iron and carbon dioxide that are easily removed by aeration and filtration. The water from the terrace deposits is very hard.



## *World's Tallest Tower Crane in Action*

**What is said to be the tallest tower crane is in use on the Pirelli's skyscraper now under construction in Milan, Italy. The crane was raised another 70 ft after this photo was taken to bring it to the record height of 460 ft. It will lift 1.6 ton at 200 fpm. Weight of the tower and crane with 82-ft jib is 110 U.S. tons.**

## Aluminum in New Form for Bridges



**Prototype aluminum bridge is shown under test at Lehigh University. Special Swiss-built jacks apply stress to the 50-ft span Fairchild Aluminum Bridge, which features monocoque design. The triangular beams of aluminum carry the dead load; the composite concrete deck increases the carrying capacity to handle highway loads.**

Monocoque (stressed skin) construction is the basis of design of an aluminum bridge of 50-ft span now under test at Lehigh University. This new concept for bridges follows proven aircraft design principles. It is being developed by the Fairchild Engine and Airplane Corporation, with the co-sponsorship of the U.S. Bureau of Public Roads; the Aluminum Company of America; Kaiser Aluminum and Chemical Sales, Inc.; Metals Division, Olin Mathieson Chemical Corp.; and the Reynolds Metals Company. Prof. William J. Eney, director of the Fritz Engineering Laboratory at Lehigh University, is supervising the tests.

The test section consists of three 50-ft-triangular beams of 0.081-in. rolled aluminum sheet, stiffened by aluminum extrusions riveted to the sides of each sheet. The three triangular beams are connected, edge-to-edge, by Townsend bolts at the top to form a plate 24 ft wide; this is the roadway base. A sheet of 0.125-in. aluminum forms the bottom plate. A concrete roadway, joined to the bridge by shear ties, becomes a composite structural member of the bridge. Alloy 6061-T6 is used for all aluminum applications in the bridge.

The vertical sides of the triangular beams form six canted webs, which are the principal shear members. Extruded aluminum bulb-angle stiffeners are riveted to the canted webs and bottom plate to assure the buckling integrity of the panels. A transverse thermal beam is used at each end of the bridge section, about 2 ft from each end. These two beams make adjustments for differences in rate of expansion of aluminum and concrete over a temperature range of 200 deg F.

Some 130 instruments are installed to record the behavior of the bridge under both static and dynamic loading. Static tests include loads up to 150 percent of design moment; static loads eccentrically placed on the structure 6 ft from the center of the roadway at 125 percent of design moment; and cyclic testing, also at 150 percent of design moment.

The bridge has been subjected to more than one million load cycles, representing more than 100 years normal service. Loads ranged up to 152 tons, or 175 percent of the design vehicular load limit.

The bridge is said to be in the best competitive position for spans over 80 ft and for orders sufficiently large to utilize mass production in a factory. The light weight alleviates some of the transportation problems of factory fabrication.

Consensus of those who have studied the radically different aluminum span is that it has good future possibilities. Many have ideas of how this prototype can be improved, especially those most directly connected with this Fairchild Aluminum Bridge project.

## ASCE Members Prominent at ASTM Meeting

Professor Kenneth B. Woods, M.ASCE, Head, School of Civil Engineering, and Director, Joint Highway Research Project, Purdue University, was elected President of the American Society for Testing Materials for a one-year term at the society's recent meeting in Boston. A. Allan Bates, M.ASCE, Vice-President of Research and Development, Portland Cement Association, was elected Vice-President for a two-year term.

At the President's Luncheon eight members were recognized for their completion of 50 years continuous ASTM membership. They are: H. Austill, M.ASCE; Roland P. Davis, M.ASCE; Henry A. Gardner; Prevost Hubbard, Aff. ASCE; Albert J. Loepsinger; Frank M. Masters, M.ASCE; Charles E. Paul, M.ASCE; and H. H. Scofield.

Some Society awards, presented during the annual meeting, went to ASCE members: The Sanford E. Thompson Award was presented to Tien S. Chang and Clyde E. Kesler, A.M.ASCE, Instructor and Professor, Theoretical and Applied Mechanics, respectively, University of Illinois, for their paper entitled "Correlation of Sonic Properties of Concrete with Creep and Relaxation," which was published in the 1956 ASTM *Proceedings*. The C. A. Hogentogler Award was given this year to Donald M. Burmister, M.ASCE, Professor of Civil Engineering, Columbia University, for his paper, "Application of Environmental Testing of Soils," published in the 1956 ASTM *Proceedings*.

## Stone & Webster Revises Foreign Operations

Stone & Webster Engineering Corporation announces expansion of its foreign operations in Europe with the formation of a Netherlands subsidiary and further integration of its British, French and Australian subsidiaries. The Dutch subsidiary will be known as Stone & Webster Engineering N. V., and will have headquarters in The Hague.

T. Cortland Williams, president of Stone & Webster Engineering, announced a change of name for Stone & Webster Engineering affiliates in Britain, France and Australia. In Britain, E. B. Badger & Sons, Ltd., which was founded in 1938 and merged with Stone & Webster in 1951, becomes Stone & Webster Engineering Limited. The French subsidiary, formerly known as Etablissements Badger, S. A., will be known as Stone & Webster Engineering S. A. In Australia, the subsidiary company known as E. B. Badger & Sons Pty. Limited, will become Stone & Webster Pty., Limited.

## Contracts Awarded for International Airport Job

Two contracts covering major improvements at New York International Airport have been awarded by the Port of New York Authority. A $6,046,969 contract for paving and utilities for the new $12,000,000 Instrument Runway has been let to the low bidders—the Tufano Contracting Corporation and the O. and E. Contracting Co., Inc.—a joint venture with headquarters in Flushing, N. Y. The other contract, for $1,094,367, has been awarded to Hendrickson Brothers, Inc., of Valley Stream, N. Y., for installation of utilities and paving of roadways and taxiways leading into one of the hangar sites. Work on both contracts will start now, with completion scheduled for next spring.

## Construction Industry to Have Chicago Conference

Creative trends in urban building will be the theme of the fourth annual National Construction Industry Conference, set for the Sherman Hotel in Chicago, December 10 and 11. The program will include some sixteen papers, dealing with new structural concepts, elements, and techniques, as well as the social, economic, political, and other forces affecting modern construction.

ASCE will participate in the Conference through its Construction, City Planning, and Structural Divisions. The other sponsors are Armour Research Foundation of Illinois Institute of Technology, the American Institute of Architects, the Associated General Contractors of America, and the Building Research Institute.

Inquiries about the conference should be sent to Conference Chairman R. T. Mijanovich, Armour Research Foundation, 10 West 35th Street, Chicago 16, Ill.

## Architect-Engineer for Consumers Nuclear Plant

The Atomic Energy Commission has selected the Bechtel Corporation, of San Francisco, as architect-engineer for the nuclear reactor it will build at Hallam, Nebr., under a cooperative arrangement with the Consumers Public Power District of Nebraska. The project will consist of a sodium graphite reactor feeding equipment. Operated by Consumers as part of its electrical generating system, the plant will have a capacity of 75,000 ekw. About three and a half years will be required for completing the project.

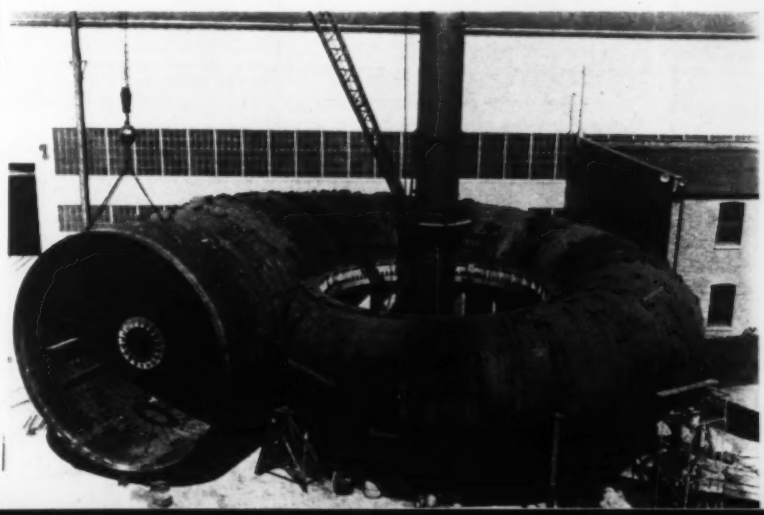
Technical responsibility for the nuclear reactor facilities will be handled by Atomics International, a division of North American Aviation, Inc., of Los Angeles. The cost of the reactor part of the plant will be about $29,000,000.

## *Pittsburgh to Have Retractable Stainless Steel Dome*

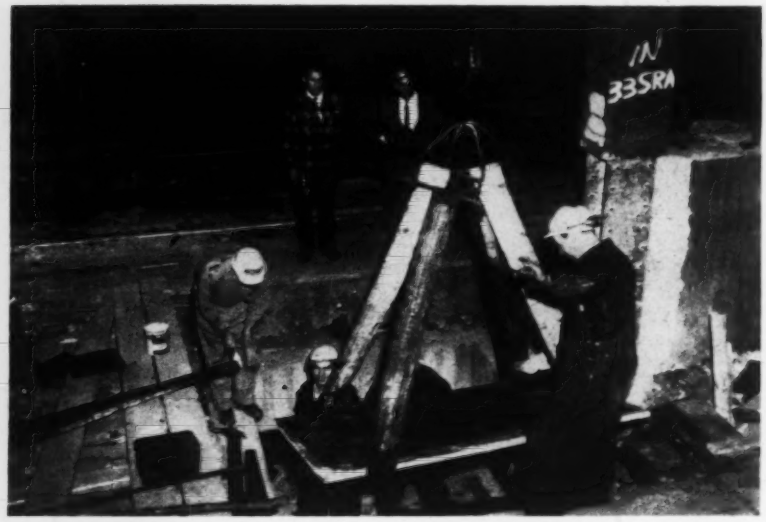
**A spectacular stainless steel retractable dome, shown here in architect's rendering, will be a key feature in Pittsburgh's new $20,000,000 Civic Arena for which footings and foundation work is currently underway. The mammoth 415-ft.-dia movable roof, first such dome ever built, will provide the city with a versatile open-air stadium that can be converted to a weatherproof auditorium by pressing a button. Seating capacity will range between 7,500 and 14,000, depending on the type of use required. When the roof is retracted, six movable sections (three on each side) will roll over the two fixed sections. Architects for the Civic Arena—Mitchell & Ritchey of Pittsburgh—specified 20- and 22-gage type 302 18-8 stainless steel in a special dull finish for the skin of the dome. It will be fabricated by the Limbach Company, of Pittsburgh. The American Bridge Division will supply the $4,000,000 worth of structural steel forming the dome. Ammann & Whitney, of New York City, are the engineering consultants on the design of the unique roof. Completion is scheduled for late 1960.**

## *Turbine Scroll Case for Noxon Rapids Dam*

**One of the largest turbine scroll cases ever built in the United States has been shipped to the site of the Noxon Rapids Dam in western Montana by the Chicago Bridge and Iron Company, Chicago. Because of its size the 24-ft-dia case, shown here during shop fit-up, was dismantled for rail shipment to the dam site where it was welded together. Constructed of T-1 alloy steel, the scroll case is the first of four to be fabricated and erected by Chicago Bridge and Iron for the dam—an $87,000,000 project under construction by the Washington Water Power Company.**



## *Lead to Insulate New York City Skyscraper from Train Vibration*




Lead-asbestos pads—placed beneath the 115 steel columns that will support Union Carbide's new skyscraper headquarters in New York—will cushion the building against vibration from railroad traffic running in and out of Grand Central Station. The 54-story structure is going up at 270 Park Avenue, directly over a dense network of tracks. The floor of each column is set in a concrete protective pier, lined with lead-asbestos anti-vibration pads. The pads are sandwich structures, with a core of 12-gage steel. The principle of the procedure is resistance to transmission of shock waves from one material to another. Lead was chosen because of its durability and lack of resilience. Photo shows one of the anti-vibration pads being lowered into position on column footing. The structural engineers on the skyscraper project are Weiskopf & Pickworth; the mechanical engineers, Syska & Hennessy; the architects, Skidmore, Owings & Merrill; and the general contractor, the George A. Fuller Company. The pads were made by John F. Abernethy & Co., Inc.

## Contract Awarded for Pan American Terminal

Construction of Pan American World Airways' revolutionary new $8,000,000 air terminal at New York International Airport will start at once, following award of a building contract to the Turner Construction Company, of New York. Designed to handle a fully loaded jet airliner every 15 minutes, the new terminal features two major new developments in passenger service: (1) a cantilever roof extending out over incoming and outgoing planes, umbrella style, to protect passengers from the weather, and (2) a streamlined design to speed passengers to their planes without the usual long walks and stair climbing.

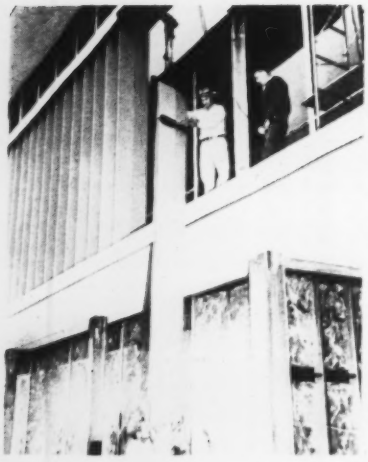
The terminal was designed by the New York engineering firm of Tippets, Abbett, McCarthy & Stratton, with Ives, Turano & Gardner as associate architects. Completion is scheduled for the fall of 1959.

## Russian Technical Translations Available

American science and industry will now have access to translations of a large amount of Soviet technical information through a Foreign Technical Information Center, which has been set up in the Department of Commerce. The Center is part of the Office of Technical Services.

The new program will add substantially to the wealth of technical information OTS is equipped to supply to industry in any field, according to Secretary of Commerce Sinclair Weeks. The OTS is well equipped to handle the new program. Since 1945 it has been collecting, cataloguing, and publishing reports resulting from government-sponsored research.

Inquiries should be addressed to the OTS, U. S. Department of Commerce, Washington 25, D. C.



## *Astronomical Clock Moves Protective Louvers*

One of 880 giant aluminum sun louvers (14 ft high and 22 in. wide) is being installed at new Reynolds Metals Company general office building in Richmond, Va. Adjustable louvers, geared to an astronomical clock which will anticipate the movement of the sun through the year 2100 A. D., will shield eastern and western faces of building from heat and glare, thus acting as "preventive air-conditioning." A total of 1,235,000 lb of aluminum were used in constructing and furnishing the $11.5 million structure, which exemplifies aluminum's role as the metal of experiment of the twentieth century.

# Weldynamics

## ARC WELDING AT WORK CUTTING COSTS

*New Carquinez Bridge being fabricated and erected by American Bridge Division, U. S. Steel Corporation for the State of California.*

*Mechanized Manual Lincolnweld Submerged Arc Welder makes ½ inch fillet welds on corners of box sections.*

## WELDED CARQUINEZ STRAIT BRIDGE

### *gives taxpayers more for their money*

THE use of welded fabrication and USS T-1 and A 242 high tensile steels in the construction of the Carquinez Strait Bridge will save the State of California almost $1,000,000.

Welded design saved tons of steel, simplified detailing, and produced a better looking bridge that will be easier to maintain than its riveted counterpart.

The heavy structural members were shop fabricated using Lincolnweld Automatic and Semi-Automatic Submerged Arc Welders. The Lincoln machines provided the speed and precise control necessary to keep welding costs at a minimum while producing dependable welds of the very highest quality.

Progress in bridge design is measured by the increased use of welded design . . . for better bridges at lower cost.

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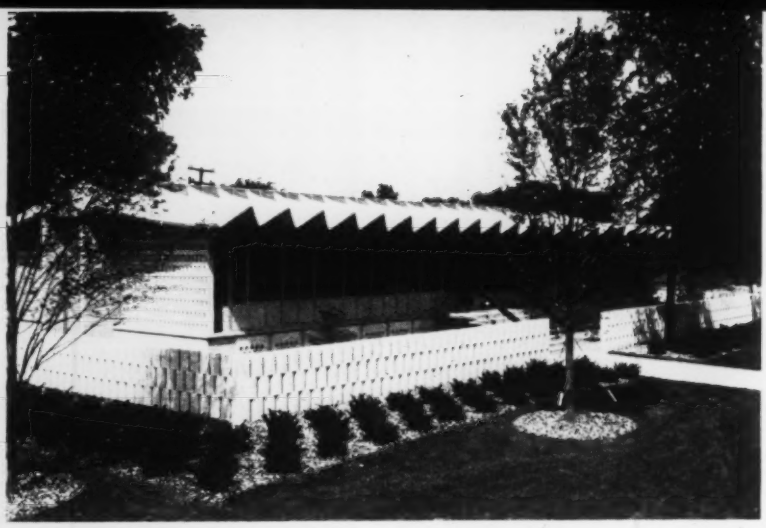

## New A.C.I. Headquarters—A Showpiece in Concrete

**Keynoting the era of modern thinking in concrete construction, the new American Concrete Institute headquarters building in Detroit, Mich., is a milestone in concrete technology. As a showpiece in concrete, the unique structure displays the latest developments and techniques in concrete construction. The structure, featuring a roof of precast cantilevered folded plate units, will be dedicated late this month. The ultramodern builing was designed by Minora Yamasaki of Yamasaki, Leinweber and Associates of Birmingham, Mich. Ammann & Whitney, of New York and Milwaukee, were structural consultants on the project, with Pulte-Strang, Inc., of Ferndale, Mich., the general contractor.**

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# N*G*Neare's N*G*Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

"I learned some lawnmower geometry last month," teased Joe Kerr.

"I can guess what you mean," guessed the Professor, "but you tell us."

"Well, first of all, if you mow a strip around the perimeter of a polygonal lawn leaving a new polygon of the same number of sides, respectively parallel to and equidistant from the original sides, the area mowed in terms of the width of the strip and its perimeters is

$$A = \tfrac{1}{2}w(P_o + P_n)$$

The second lesson was that if the strip just eliminates one side, the new polygon still qualifies, by considering it to have one side of zero length. So when the first strip cut a 756-sq-ft pentagon down to a 360-sq-ft quadrilateral, the next strip cut this to a 96-sq-ft triangle, and the last strip finished the job, I found three equations

$$\tfrac{1}{2}w(P_5 + P_4) = 756 - 360 = 396 \quad ..(1)$$
$$\tfrac{1}{2}w(P_4 + P_3) = 360 - 96 = 264 \quad ....(2)$$
$$\tfrac{1}{2}w(P_3 + 0) = 96 - 0 = 96 \quad .....(3)$$

Then, adding (1) to (3) and subtracting (2)

$$\tfrac{1}{2}wP_5 = 396 + 96 - 264 = 228 \quad .....(4)$$

"Since you just asked for the original perimeter, $P_5$, all I need to know is what size lawnmower your engineer friend in Portland used, since w equals 3 swaths.

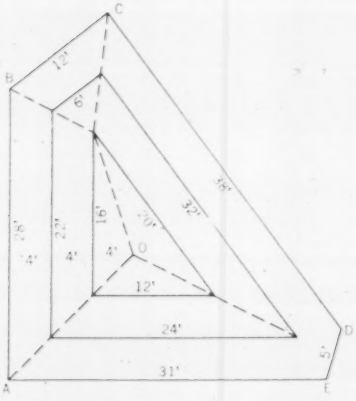



**Fig. 1. The pentagonal lawn Joe mowed a la Mode.**

Well, from the last equation, it can't be a power mower, for even if the 96-sq-ft triangle was equilateral with w = 4.2983, the swath would be only 17.2 in. So I guessed 16 in., like my old grunt-power mower, making w = 4 ft and $P_5$ = 114 ft."

"There goes Joe guessing again," complained Cal Klater. "Lucky this time, tho, because my usual elegant and rigorous analysis led thru a pair of simultaneous cubics to this same simple answer. Here's a map of the yard to prove it."

"I like to guess, too," sighed Professor Neare, "so I guess I'll give you both A's and advise high-school geometry teachers to assign more lawn mowing for home work. Cal's more difficult problem was to meet the conditions that angles A and C were equal and so were angles B and D, which make the solution unique.

"The old truel problem has been revived lately in several different forms and I have a version that will intrigue those interested in probability and tactics. The truel, you know, is like a duel except that there are three combatants. Standing at vertices of an equilateral triangle, they fire in turn at any target, in an order predetermined by lot, until only one survives as the winner. In this version the combatants had just measured their relative skills in target practice. Each firing 80 rounds. Abel scored 72 bulls, Bart 70, and Cam only 23. How unfair was the truel?"

*[Kerrs and Klaters were Ed C. Holt, Jr., Sauer Doe (Marvin Larson), and Thatchrite (Guy C. Thatcher). Also acknowledged are solutions to recent problems from Thatchrite and John A. Scaville Jr.]*

## Decline in July Housing Starts

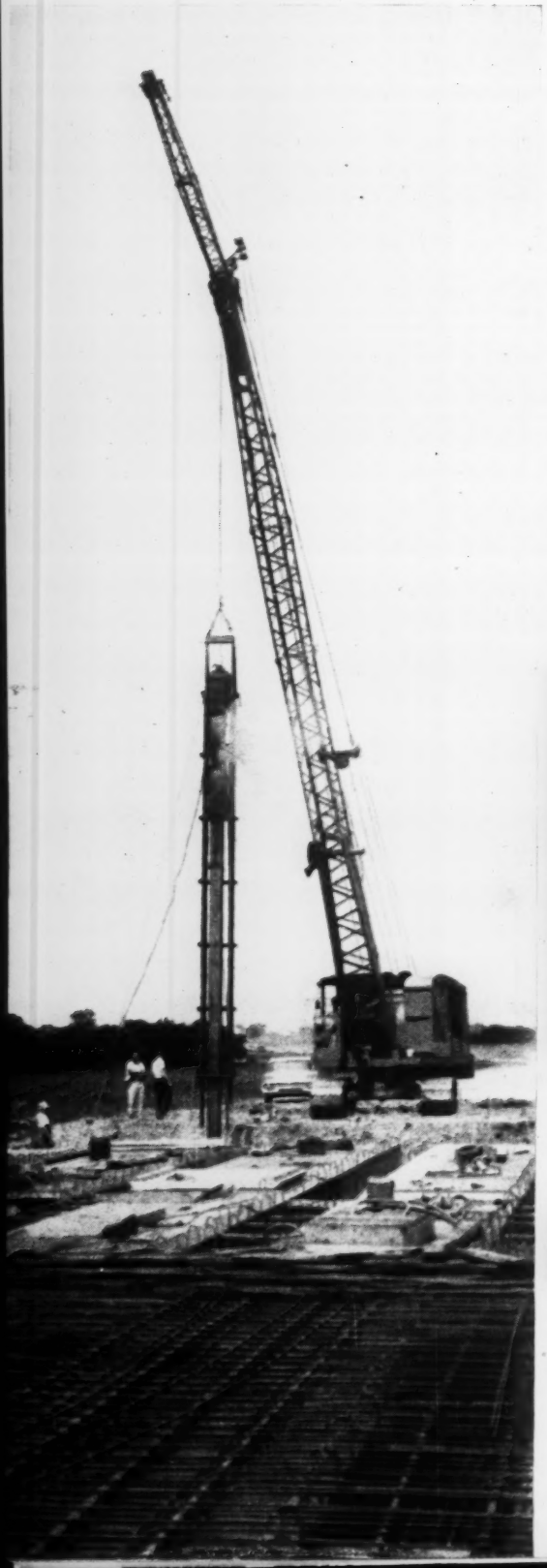
Nonfarm housing starts totaled 111,000 in July, according to preliminary estimates of the U.S. Labor Department's Bureau of Labor Statistics. The decline of 4,000 units from June was less than usual for the time of year, and the July total exceeded the figure for July 1957 by 13,000 units, or nearly 14 percent. A drop in public housing accounted for the decrease from June. Privately owned housing starts, which usually decline in July, rose a little this year (by 2,800 units) to a total of 107,300. This represented a gain of 14 percent over July 1957, to the largest private total for any month since May 1955. The increase from June was entirely in housing begun under FHA and VA mortgage insurance programs.

On a seasonally adjusted basis, private starts in July were at an annual rate of 1,160,000, the highest in over two years. When averaged for the first seven months, the annual rate of private starts thus far in 1958 was 1,013,700 units, compared with an average of 970,900 units for the same 1957 period. The July advance in private homebuilding occurred primarily in the North Central and Western states.

# Kansas Highway Program moves even faster...

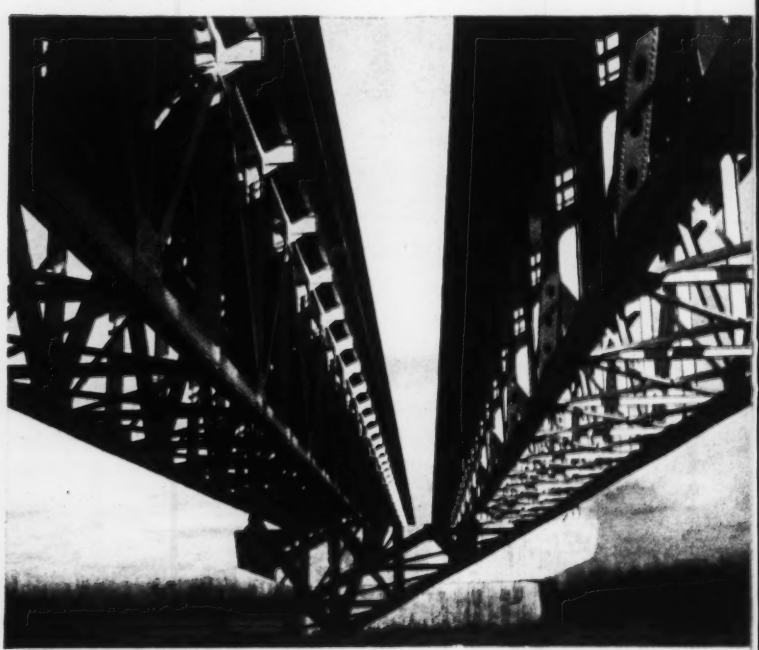
Kansas was the first state to complete a construction contract under the Federal Interstate Highway Program begun in 1956. On November 14 of last year, an 8-mile section of U.S. Route 40 was opened to traffic. In the first years of the Federal Highway Program, Kansas has appropriated an average of 33.4 million dollars annually for highway improvement. Plans for the next few years are based on spending an increased amount annually. Presently approved is the sum of $63,453,020 for grading, draining, surfacing, landscaping and bridge construction on 130 miles of roadway. 16.8 miles of urban roadways will cost 16.9 million dollars; 114 miles of rural roadways will cost 46.4 million dollars. The Kansas Highway Program is under the direction of Maurice Martin, Director of the State Highway Commission.

# ...and products of United States Steel



**Kansas Interstate System grows!** 770 miles of Interstate Highway will cross Kansas from east to west and connect its principal cities with neighboring Oklahoma to the south. About 175 miles of the Kansas Turnpike have been incorporated into the Interstate System. Now under construction are 15.5 miles of Route 40 between Topeka and Junction City and 52 miles of Route 35 between Kansas City and Ottawa.

**On Route 35** USS Steel H-Beam Bearing Piles are driven down to bedrock for a bridge over Ottawa Creek. USS Steel Bearing Piles speed the solution of difficult foundation problems economically. And for concrete construction, USS *Di-Lok* Reinforcing Bars have a continuous diamond-locking deformation that strengthens the bond between concrete and steel, providing positive anchorage and prohibiting longitudinal movement of the bars.



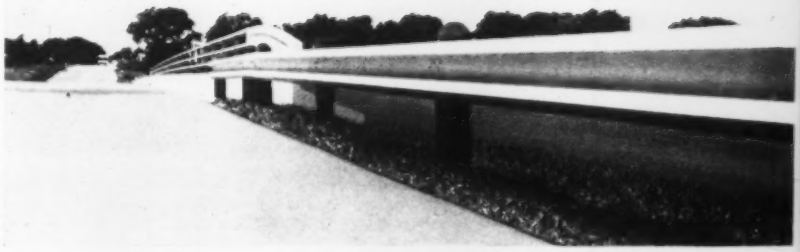
**500 tons of steel** and an estimated $100,000 were saved by using USS *Tri-Ten* Steel in heavily stressed chords and diagonals on this, the largest bridge in the Kansas Turnpike. These parts were able to be made thinner and lighter because of *Tri-Ten* Steel's greater strength. With a yield point of 50,000 psi minimum, *Tri-Ten* Steel meets all requirements of ASTM Specification A-242 for high-strength low-alloy steel.

# el help keep it moving along!

**Welded Wire Fabric** goes down on Route 35. USS *American* Welded Wire Fabric is a top-quality, cold-drawn steel wire able to withstand high unit stresses and permits construction of slabs up to 100 feet long for a smoother riding surface. *American* Transverse Road Joint Load Transfer Assemblies and *American Super-Tens* Stress-Relieved Strand and Wire are also available to add strength and long life to various concrete applications.

**This stretch** of pavement was constructed under the first contract completed under the Federal Interstate Highway Program. Companion two-lane strip of U.S. Route 40 west of Topeka is ready for paving. Most Kansas Interstate Highways will feature medians of 60 feet to allow construction of two additional lanes between strips now planned. Universal Atlas Cement Division of United States Steel furnishes *Atlas Duraplastic* air-entraining cement, *Universal* regular and air-entraining portland slag cements, *Atlas* regular and air-entraining high-early cement, as well as *Universal* and *Atlas* portland cements to meet every concrete paving need.

**USS American** Highway Beam Guard Rails for interchanges, fill sections, and curves help control the effects of recklessness and will safeguard traffic at designated speeds. "Western" Highway Guard Rail (in the Pacific coast area) and USS *American* Multisafty Cable Highway Guard are also available to help build safety into thousands of potential trouble spots along the Federal Interstate System.



**Drainage of median strips** on U.S. Route 40 is carried through corrugated pipe fabricated from USS Culvert Sheets to flare plate which distributes run-off onto shelf rock. Many cattle passes and hundreds of miles of expressways are guarded by USS *American* fence to prevent livestock and wild animals from wandering on to roadways to endanger themselves and travelers.

*USS and trademarks in italics are registered by U. S. Steel*

**Get this free catalog!** 54 pages packed with information about products that will help you cut costs and speed all phases of highway construction. It is your guide to all highway products and services available through United States Steel. Write to United States Steel Corporation, Room 2801, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS United States Steel

**Divisions of United States Steel serving the highway market:** American Bridge Division, Pittsburgh, Pa. American Steel & Wire Division and Cyclone Fence Department, Cleveland, Ohio • Columbia-Geneva Steel Division, San Francisco, Calif. • Consolidated Western Steel Division, Los Angeles, Calif. • National Tube Division, Pittsburgh, Pa. • Tennessee Coal & Iron Division, Fairfield, Alabama • Universal Atlas Cement Division, New York • United States Steel Supply Division, Steel Service Centers, Chicago, Illinois.

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*Smith-Field Automatic Curb and Gutter Machine in operation.*

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NO HAND FINISHING!
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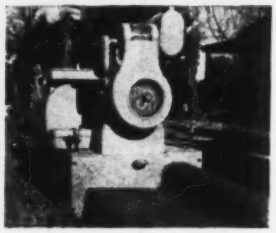
The Smith-Field Automatic Curb and Gutter Machine uses Portland Cement Concrete. The Stephens-Canfield Automatic Curbers work equally well with either cement or asphalt mix.

TYPICAL MOLD SECTIONS—65 OTHERS AVAILABLE

**LEARN about the savings — the efficiency of these machines. Write for full details and prices.**



*Smith-Field Automatic Curb and Gutter Machine — Model Mark 3*

*Stephens-Canfield Automatic Offset Curber — Model 56W*

*Stephens-Canfield Automatic Curber — Model 55A*

**E. L. HARDIN ASSOCIATES, INC.**
SALISBURY, NORTH CAROLINA U. S. A.


## NEW PUBLICATIONS

*(Continued from page 36)*

**Protecting buildings from fire . . . .** For the benefit of architects, engineers, and others concerned with the protection of buildings against fire and natural hazards, the National Board of Fire Underwriters has just issued a 22-page booklet explaining the factors affecting loss possibilities. These factors include type of construction, fire-resistant roof coverings, and safe chimney construction. Also discussed are loss possibilities from earthquakes, floods, lightning, termites, and windstorms. Single copies of the booklet are available from the National Board of Fire Underwriters without cost. For persons living in the East, the address is 85 John Street, New York 36, N. Y.; in the Middle West, 222 West Adams Street, Chicago 6, Ill.; and west of the Rockies, 465 California Street, San Francisco 4, Calif.

**Atomic energy . . . .** As a service to participants in the nuclear industry, the Document Service of the Chronicle of United Nations Activities is listing the titles of papers to be delivered at the Second International Conference on the Peaceful Uses of Atomic Energy, in Geneva this September. Over a thousand titles have been announced in the May and June issues of "The Chronicle of United Nations Activities." Free copies are available. The Chronicle should be addressed at 234 West 26th Street, New York 1, N. Y.

**Highway research . . . .** In its Special Report 29, the Highway Research Board summarizes the results of several years of work by its Committee on Landslide Investigations. Entitled "Landslides and Engineering Practice," the 232-page illustrated publication is a valuable reference for engineers who must design for, or correct, the more important types of landslide movement. Copies, priced at $6.00 each, are available from the Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C.

**Standards . . . .** Availability of the Proceedings of the Eighth National Conference on Standards, held in San Francisco in November 1957, is announced by the American Standards Association. The 160-page volume, entitled "Standards—Key to Progress and Profits"—presents 44 papers by authorities from government, science, and industry. It may be purchased from Dept. DD-6, American Standards Association, 70 East 45th Street, New York 17, N. Y., at $4.00 a copy.

**Sanitary engineering . . . .** The status of sanitary engineering in Peru is the subject of a brochure recently released by the University of North Carolina School of Public Health. The report is the result of a four-year project for technical assistance to the National University of Engineering of Peru, sponsored by the International Cooperation Administration and the Institute of Inter-American Affairs. Inquiries should be sent to the Department of Sanitary Engineering, University of North Carolina, Chapel Hill, N. C.

**Commercial laboratories . . . .** A "Directory of Independent Commercial Laboratories Performing Research and Development, 1957," has been released by the National Science Foundation. The valuable reference lists 565 laboratories, together with names of senior officers, size of the research staff, and types of research activities. Copies, at 40 cents each, may be ordered from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

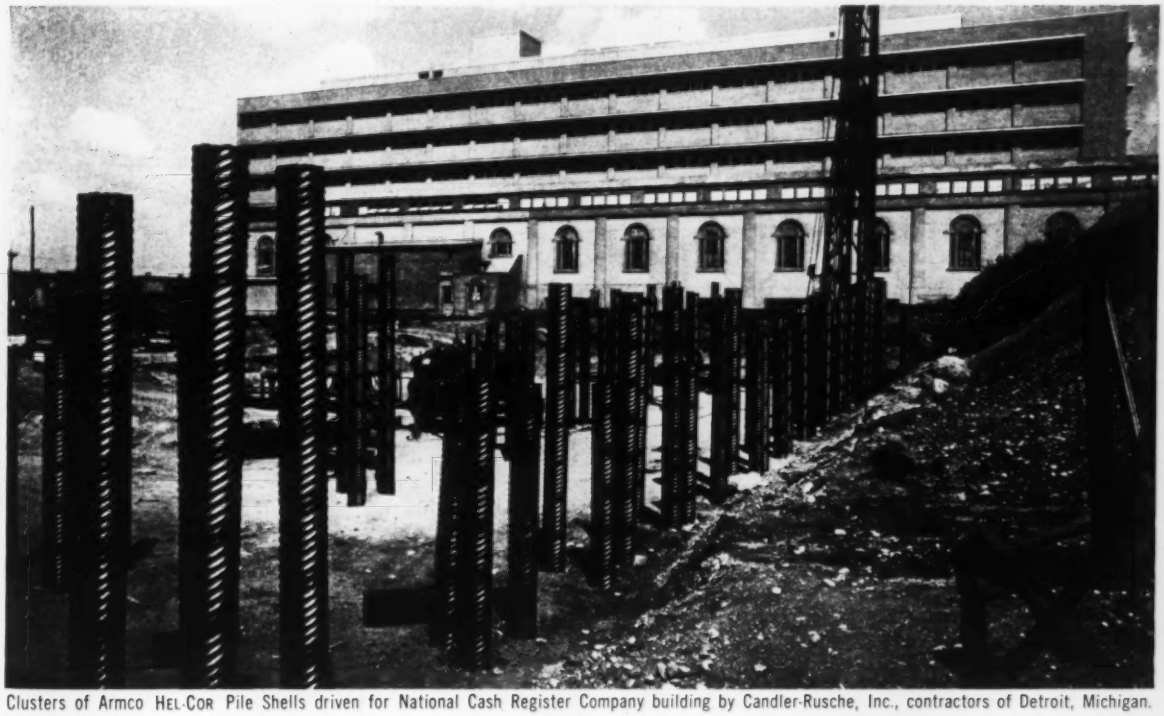
**Structural arc welding . . . .** A prize-winning AWS article on "The Plastic Behavior of Structural Members and Frames" has been reprinted from *The Welding Journal* through the courtesy of the James F. Lincoln Arc Welding Foundation. Free copies are available to engineers, professors, students, and fabricators, upon request to the Foundation, P. O. Box 3035, Cleveland 17, Ohio. Authors of the paper, which received the 1957 A. F. Davis Medal for a notable contribution to structural arc welding, are Lynn S. Beedle, A.M.ASCE, and George C. Driscoll, Jr., J.M. ASCE.

**Parking the big cars . . . .** For the convenience of designers of parking garages and others concerned with traffic engineering, the Automobile Manufacturers Association has compiled a listing

*(Continued on page 130)*

# Solid foundation on unstable soil

## 12,000 feet of Armco HEL-COR Pile Shells driven for foundation of new National Cash Register Company building



Clusters of Armco HEL-COR Pile Shells driven for National Cash Register Company building by Candler-Rusche, Inc., contractors of Detroit, Michigan.

The site of National Cash Register Company's new Building 31 in Dayton, Ohio, now under construction, was formerly part of the old Miami-Erie Canal. Over the years, a variety of fill material had been deposited there. Consequently, a more stable foundation for the building was needed.

Considering results of numerous test borings and the weight of the completed building, it was decided to use Armco HEL-COR® Pile Shells to provide a good foundation for the structure. The Pile Shells were driven in clusters of 2, 3, and 4, and capped with concrete slabs. In all, 12,000 feet of piling, 12½" O.D., 16 gage, was supplied in 18-, 25-, and 50-foot lengths.

Leading engineers and contractors throughout the country specify Armco Piling and other Armco Construction Products for thousands of large and small construction jobs. There is a size and type of Armco Product to help you solve almost any drainage or construction problem.

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Architect's rendering of Building 31 of the National Cash Register Company.

**Armco Construction Products**

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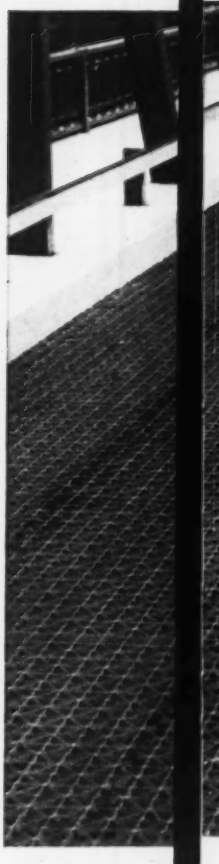
Minneapolis' new Lowry Avenue Bridge. Designed by Eric Jorgenson, City of Minneapolis Bridge Engineer, now retired. All photos by Alan Ostlund, Minneapolis.

# MINNEAPOLIS' Now Floored Unique

Greulich 4-Way Grid has been partially laid here, but not welded, and is providing excellent platform for workmen to use.

Another scene showing grid in use as a working platform. Here floor beams from the old bridge are being easily removed.



The Lowry Avenue Bridge, reconstructed by the City of Minneapolis and opened to traffic during the early part of July, 1958, presents a rather unique construction technique.

The old floor system was supported on falsework as a working platform for erecting the new bridge. The old trusses were removed. Piers were widened and raised and new steel trusses erected.

After the new trusses were erected, Greulich 4-Way Grid 5-inch open steel flooring was placed, but not welded. As the flooring progressed the floor beams from the old bridge were removed by a truck crane resting on the grid floor. This presented a good test of Greulich 4-Way Grid's rugged, all welded construction and it came through with flying colors.

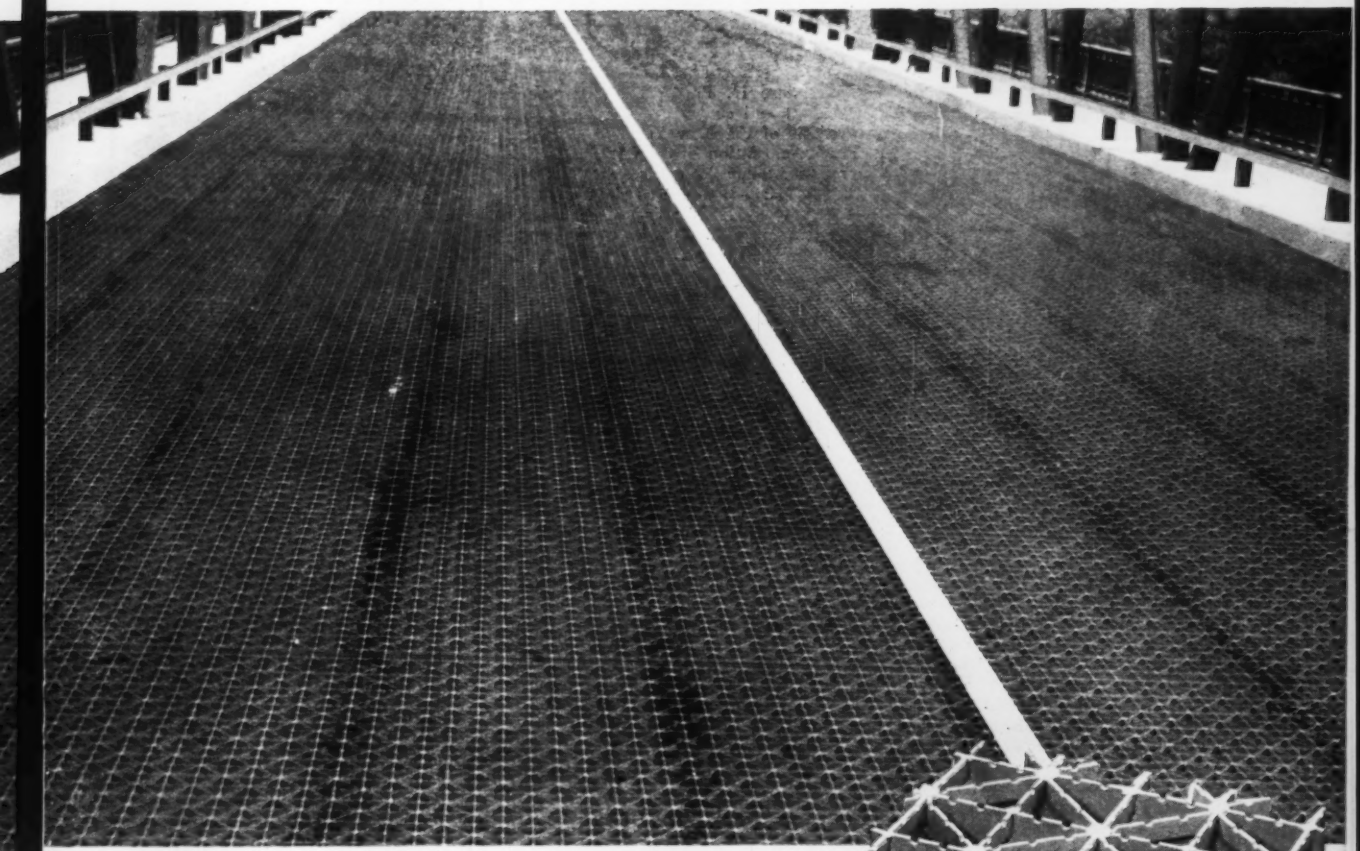
Today, four lanes of traffic flow across the Mississippi River on the new Lowry Avenue Bridge, relieving one more traffic problem for a progressive city. Since open grid does not retain snow in winter this bridge will give a year-round crossing.

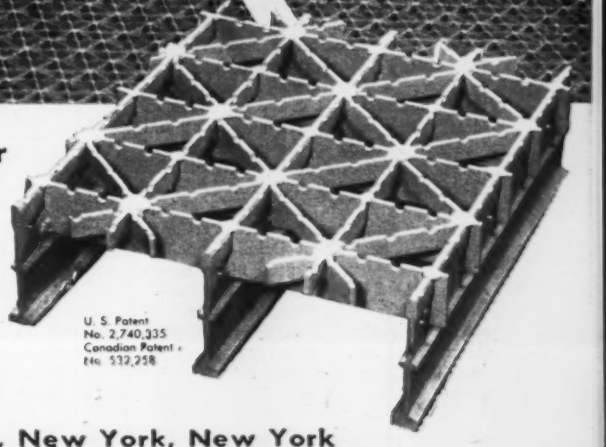
## QUICK FACTS ABOUT GREULICH 4-WAY GRID

Integrally connected triangles of the grid provide a flat, single-plane, serrated surface over entire roadway to insure maximum lateral or horizontal rigidity. 7½" spacing of main bearing members permits installation with 20% fewer field welds with no loss of strength. Panels 7 ft. 3" wide hold handling costs down but still permit hauling on flat bed trucks. Grid can be filled half depth with concrete where a closed surface is desired. For additional facts, write Harvey F. Neel, Mgr., Division C-10, Kerrigan Iron Works, Inc., Nashville, Tenn.

**Bridge Flooring Division (Harvey F. Neel, Manager), Nashville, Tennessee**

# LOWRY AVENUE BRIDGE
## with GREULICH 4-WAY GRID Construction Technique Used!





- Stronger
- Quieter
- 20% Fewer Field Welds

U. S. Patent No. 2,740,335
Canadian Patent No. 532,298

THE FORGES OF KERRIGAN

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# DECEASED

**Walter R. Drury** (M. '37), age 68, retired partner in Drury, McNamee and Porter, Ann Arbor, Mich., engineers, died there on August 17, 1957. A graduate of the University of Michigan College of Engineering, Mr. Drury spent his early years as assistant city engineer of Ann Arbor and then of Flint. In 1921, he became a partner in the Hoad, Decker, Shoecraft and Drury firm. When he became a senior partner, the firm's name was changed to Drury, McNamee and Porter. Mr. Drury retired in 1953.

W. R. Drury

**Philip P. Farley** (M. '10), age 87, consulting engineer for the Office of the President of the Borough of Brooklyn, Brooklyn, N. Y., died on April 19. Mr. Farley received his B.S. and C.E. degrees from Cooper Union. During his early career, he served as assistant engineer on the New York Rapid Transit Commission and was in charge of the construction of twin tunnels under Murray Hill. For several years he was president of the Jamaica Bay Improvement Commission. Mr. Farley had been in the office of the Borough President since 1919.

**James Forgie** (M. '04), age 90, New York consultant and authority on tunnels, died at his home in Kew Gardens, N. Y., on August 13. A native of Scotland, Mr. Forgie was educated at Gordon's College in Aberdeen. As an associate of the firms Sir Benjamin Baker & Company and Sir Basil Mott and Hay, Mr. Forgie participated in the design and construction of rapid transit tunnels under London and the Thames. He was called to the United States to aid in the design and construction of the tunnels under the East and Hudson Rivers in New York. While a partner in Jacob and Davies, consulting engineers, he worked on the construction of the Hudson and Manhattan Railway tunnels. Long in private practice, Mr. Forgie was employed on tunnel construction in Canada, Mexico, and Great Britain. His last project was the supervision of construction on the New Union Tunnel under Baltimore for the Pennsylvania Railroad. The author of many engineering monographs, Mr. Forgie contributed an article on tunnels to the Encyclopedia Brittanica.

**Philip L. Pratley** (M. '40), age 73, noted Canadian consultant, died recently in Montreal. A native of Liverpool, England, Mr. Pratley was educated there and received his B.S. and B.E. degrees from Liverpool University. He had been in Canada since 1905 and spent several years as designer for the Quebec Bridge Board. In 1921 he and the late C. N. Monserrat entered into a consulting partnership that lasted until 1940. During that time, Mr. Pratley worked on the design of the Jacques Cartier Bridge, the Lion's Gate Bridge, the Niagara Arch, and the Canadian part of the Thousands Islands Bridge. Recently he was called to investigate the collapse of the second Narrows Bridge in Vancouver. At the time of his death Mr. Pratley was working on the projected Champlain Bridge from Montreal to Nun's Island.

**Theodore D. Pratt** (M. '24), retired president and chairman of the board of directors of the New York State Motor Truck Association, died on July 28 in Miami, Fla., where he made his home. Mr. Pratt began his career as chief engineer of the Central Stamping Company of Newark, N. J. In 1917 he became general manager of the New York State Motor Truck Association, handling design and transportation problems. He later rose to be president and chairman of the board of directors. At one time Mr. Pratt edited *Highway Transportation*.

**Maurice B. Smyser** (A.M. '40), age 50, superintendent and estimator with the Union Paving Company, Philadelphia, Pa., died there on July 27. Mr. Smyser, who received his civil engineering degree from the University of Pennsylvania, had been with the Union Company since 1933, serving it in many capacities. He had held the positions of engineer on estimating and supervising construction for the Pennsylvania State Highway Department, engineer and assistant superintendent on paving contracts, and assistant superintendent on construction of three federal aid contracts in the District of Columbia.

**Thomas P. Snyder** (M. '57), age 51, supervisory construction engineer with the U.S. Army Engineer District in Nouasseur, Morocco, died there on May 4. Mr. Snyder, who began engineering in supervisory capacities in 1933, had served as superintendent of construction for N. P. Turner, Sr., Texas contractor; principal inspector for the Corps of Engineers in Arkansas; and resident engineer for the Corps in California and Texas. He had also been in charge of a construction and rehabilitation program at Fort Polk, in Galveston, Tex. Mr. Snyder had been in Morocco since 1955.

**Jules Verner** (A.M. '17), age 72, retired mechanical superintendent of the Bayway Refinery of the Esso Standard Oil Company, died in Linden, N. J., on August 8. Mr. Verner, who retired from Esso in 1951, had been with the company for 40 years. A past president of the Union County Professional Engineers Society, he had served as chairman of the Rahway Harbor Commission. Mr. Verner was a former mayor of Linden.

**John C. Wehmann** (A.M. '56), age 35, chief draftsman with Howard, Needles, Tammen and Bergendoff, consulting engineers of New York City, was killed in a plane crash at Nantucket, Mass., on August 15. Mr. Wehmann was graduated from Princeton University in 1949 with high honors as a bachelor of science in civil engineering. He joined Howard, Needles, Tammen, and Bergendoff immediately after his graduation.

**Everett B. Wilson** (M. '04), age 83, retired consultant of Washington, D. C., died in Victoria, Tex., on July 27. A civil engineering graduate of the University of Delaware, Mr. Wilson was a specialist in engineering inspection and testing. From 1904 until 1934, he was president and manager of the American Bureau of Inspection and Tests in Chicago, Ill. For almost 20 years, Mr. Wilson was engaged in private practice as a consultant in Washington, D. C. He retired in the early 1950's.

## NEW PUBLICATIONS

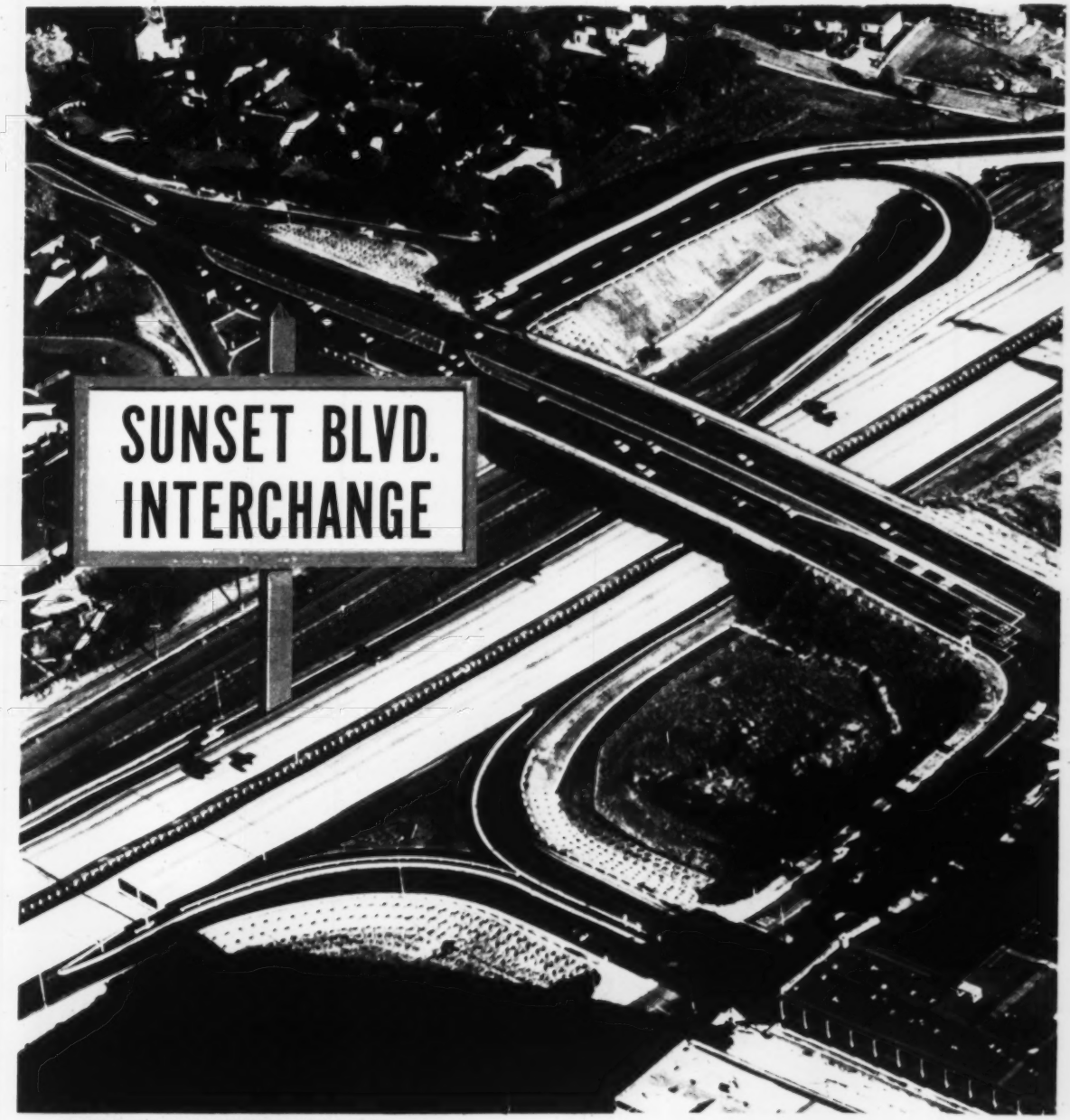
*(Continued from page 129)*

of "Parking Dimensions for 1958 Cars." Identified as AMA Engineering Notes No. 18, the handy reference may be obtained from the AMA, 320 New Center Building, Detroit 2, Mich.

**Construction plant for TVA projects** . . . . Concise information on the planning, design, construction, and removal of major steel sheetpiling cofferdams on TVA-constructed projects on the Tennessee River is provided in Volume 1, "Steel Sheetpiling Cellular Cofferdams on Rock," of its Technical Monograph No. 75, *Construction Plant for TVA Projects*. The sixth in the series of special technical reports, the present volume discusses cofferdam cell arrangements and presents actual design examples and tests, details of construction, and removal techniques. The design data were developed by TVA's Construction Plant Branch to meet the need for new information on cellular cofferdams. Copies may be purchased from the Treasurer's Office of the Tennessee Valley Authority, Knoxville, Tenn., for $2.50 each.

**Steel** . . . . "Steel and Inflation" is the title and "Fact vs. Fiction" the subtitle of a publication recently released by the U. S. Steel Corporation in response to a Senate Subcommittee attack on the pricing policies of American business and industry. The publication includes policy statements of various U. S. Steel Officials before the Subcommittee and gives "the whole financial story" of the organization. Copies of the 290-page, handsomely illustrated volume are available from the Public Relations Department, U. S. Steel Corporation, 71 Broadway, New York 6, N. Y.

*(Continued on page 132)*




Photographs courtesy California Division of Highways

STAY ON SCHEDULE WITH *Reinforced Concrete*

Although the national roadbuilding program is in high gear, there are still many rivers to bridge . . . many freeway interchanges to build. Reinforced concrete is playing a major role in this vast construction undertaking. Reports from many important projects, such as the Sunset Boulevard Interchange on the San Diego Freeway in Los Angeles, indicate that more and more highway engineers find they can count on their bridge and separation structures being "completed on time" when they design for reinforced concrete.

## Concrete Reinforcing Steel Institute

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1 Minute or
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Dumpy
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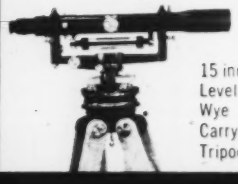
Tripod



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Level
Wye
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Tripod

Transit
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4 inch
Transit
1 Minute reading
Carrying Case
Tripod

Wye Level 12 LW-CT

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Level
Wye
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Tilting Level
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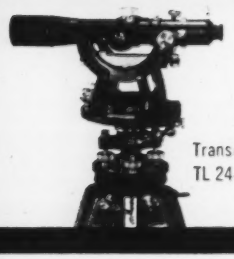

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## NEW PUBLICATIONS

(*Continued from page 130*)

**Column research** . . . . One of the important engineering projects of the past decade is the Column Research Council of Engineering Foundation. The Council has annual technical meetings to report on the year's work in the field. Release of the Proceedings of the Seventh Technical Session, held at Lehigh University in May 1957, is now announced. The important volume includes papers on the buckling length of columns; the buckling of columns, with special attention to eccentricity, plasticity, and local buckling; and the influence of residual stress on the strength of structural members. Inquiries should be addressed to the Column Research Council, 319 West Engineering Building, University of Michigan, Ann Arbor, Mich.

**Soil testing** . . . . Issuance of a compilation of standards for testing soils is announced by the American Society for Testing Materials. The 552-page publication contains 112 testing procedures. Of these 39 are new and 12 have been revised since the last (1950) edition of this reference. ASTM's Committee D-18 on Soil for Engineering Purposes has sponsored the publication, which includes all existing ASTM standards in the field. The compilation sells for $6.75. Orders should be sent to the ASTM, 1916 Race Street, Philadelphia 3, Pa.

**Air pollution** . . . . Results of a cooperative survey of the air-pollution situation in Tennessee—conducted by the U. S. Public Health Service and the State of Tennessee Department of Public Health—are reported in a recent publication entitled "Appraisal of Air Pollution in Tennessee." Copies may be obtained from the Chief of the Community Air Pollution Program, Robert A. Taft, Sanitary Engineering Center, Cincinnati, Ohio, or from the Tennessee Department of Public Health, Cordell Hull Building, Nashville 3, Tenn.

**Highway training program for engineers** . . . . For many years the Oregon State Highway Department has conducted an informal on-the-job training program for engineers. As another step toward assuring adequate highway personnel, the Department now has a formal Career Development Program for Graduate Engineers. Candidates are selected on the basis of previous work, performance, academic record, and personality traits. Full details are given in a bulletin, entitled "Career Development Program for Selected Graduate Civil Engineers." Inquiries should be sent to the Division of Personnel and Public Relations, Oregon State Highway Department, Salem, Ore.

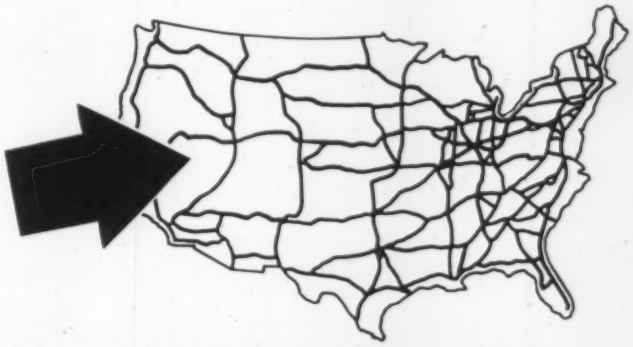
**Highway costs** . . . . A research team at the Ohio State University Engineering Experiment Station says that three groups of highway users are responsible for more than 90 percent of our highway costs—passenger cars, for 50 to 70 percent; multi-unit trucks for 10 to 30 percent; and single-unit trucks for 8 to 20 percent. These findings are reported in Engineering Experiment Station Bulletin No. 168, entitled "Highway Costs and Their Relationship to Vehicle Size." The publication is the result of a two-year investigation sponsored by the Ohio Trucking Association. The authors are Prof. Robert F. Baker, M.ASCE, who supervised the research program, and Richard W. Bletzacker and Robert Chieruzzi, Junior Members ASCE. Priced at $3.00, Bulletin No. 168 is available from the Engineering Experiment Station, Ohio State University, Columbus, Ohio.

**Standards** . . . . Availability of a "Supplementary List of Publications of the National Bureau of Standards," from July 1, 1947, to June 30, 1957, is announced by the Bureau. Issued in May 1958, the 373-page supplement may be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. The cost is $1.50.

**Safeguarding industrial and government facilities** . . . . Engineers concerned with maintenance of plants and installations may be interested in a bulletin from the Office of Defense Mobilization, entitled "Standards for Physical Security of Industrial and Governmental Facilities." The 44-page publication discusses such aspects of sabo-

(*Continued on page 136*)

# Another step toward this goal



41,000-MILE INTERSTATE HIGHWAY SYSTEM

**Paving an Interstate highway in Virginia with heavy-duty flexible Texaco Asphaltic Concrete**

The State Highway Departments are pushing ahead steadily with construction of their respective sections of the Interstate Highway System. Virginia and other States have paved a large mileage of these superhighways with hot-mix Texaco Asphaltic Concrete.

A hot-mix Texaco Asphaltic Concrete surface, on a foundation of either plant-mixed Asphaltic Concrete or Asphalt Penetration Macadam, will stand up under the heaviest Interstate Highway traffic year after year. This flexible type of construction costs substantially less than rigid paving designed for the same traffic. Maintenance costs of Asphalt paving also have been found lower by the highway departments of many States.

To the motorist, one of the chief advantages of Texaco Asphaltic Concrete paving is the velvet smooth riding quality of its resilient, joint-free surface.

Helpful information on heavy-duty Asphaltic Concrete, as well as other types of Asphalt paving, is supplied in two free Texaco booklets. Copies can be obtained without obligation by writing our nearest office.

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**Easy erection** of structural steel made possible by use of H-Beam Bearing Piles.

# Railroad jumps superhighway on USS Steel H-Beam Bearing Piles

**They do things in a big way in Chicago.** This maze of USS H-Beam Bearing Piles will soon carry four main tracks of a major railway over a temporary trestle spanning the new Northwest Route Expressway. Thus, traffic can flow on the railroad while the new overpass is being built.

**This is an excellent example** showing the versatility and strength of steel bearing piles. In this case, the piles are doing double duty. They serve as end bearing piles supporting the dead load of the temporary structural steel trestle, and, in addition, they serve as structural column bents wherein they must resist the heavy loads caused by moving trains, such as bending, sway, and thrust.

**In addition** to their great strength and rigidity, the value of steel bearing piles is further enhanced by the speed and ease of installation and the minimum amount of fabrication required to complete the trestle. A total of 2,410 tons of Steel H-Beam Piles were used in lengths from 45′ to 98′ and weights from 73 to 127 pounds per foot. As an example, the 95′ piles were driven about 65′ into the ground at a rate of 18 to 20 per 8-hour day.

**When the excavation is completed,** the piles will protrude about 45′. This is another reason for the choice of steel bearing piles. Any other pile as a substitute would expand the congestion problem and make excavation very difficult. In order to equal the strength and rigidity of steel, other types of piles would of necessity have to be more numerous and intricately braced.

For information on the use of USS H-Beam Bearing Piles, write for our free book. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

## The Project

Interstate Route No. 2, Northwest Route Expressway. Railway grade separation. Temporary Trestle. W. Kinzie St. to W. Hubbard St. **Owner:** City of Chicago, Dept. of Public Works, Bureau of Engineering. **General Contractor:** W. E. O'Neil Construction Co., Chicago, Ill. **Sub-Contractor, Pile Driving:** Fitz Simons & Connell Dredge & Dock Division of Merritt-Chapman & Scott Corp., Chicago, Ill. **Participating Agencies:** Bureau of Public Roads, Cook County Highway Dept., State of Illinois Division of Highways.

**USS Steel H-Beam Bearing Piles** to support four main tracks of a major railway on temporary trestle. Steel supplied necessary strength without bulk.

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# For construction economy...

Rodney Hunt HY-Q Flush Bottom Closure Sluice Gates offer exclusive design advantages which frequently result in substantial savings. Unlike any other design, the Rodney Hunt HY-Q gate seats on a sill flush with the invert, providing greatly improved flow characteristics over conventional gates. This in turn permits the use of a smaller gate size, a narrower channel and lower channel walls to handle a given volume of flow . . . and reduced construction costs.

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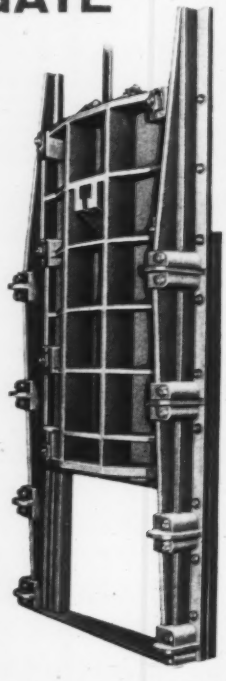

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## NEW PUBLICATIONS

*(Continued from page 132)*

tage as damage to buildings and equipment; damage to power, communications, water and sanitation systems; tampering with ventilation systems and air supply; and tampering with personnel safety devices and equipment. The bulletin is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 30 cents a copy.

**Reclamation of tidal marsh** . . . . A survey of the complex problems involved in reclaiming the Hackensack (N. J.) Meadows is reported by the Passaic Valley Citizens Planning Association. Prepared for the Meadowlands Regional Planning Board, the comprehensive report represents the first, or survey, phase of a Master Plan Series for reclamation and development of 7,000 acres of tidal marsh. The Hackensack Meadows, located as they are in the heart of the New York-New Jersey Metropolitan Area, are a potentially vast resource development. Copies of the report, identified as Master Plan Series No. 1, may be obtained from the Passaic Valley Citizens Planning Association, 312 Clifton Avenue, Clifton, N. J. The charge is $2.00 a copy.

**Air pollution** . . . . "The Air Over Louisville" is the summary of a Joint Report of a special air pollution study of Louisville and Jefferson County, Kentucky. Conducted by the Air Pollution Control District of Jefferson County, the U. S. Public Health Service, and other agencies, the survey shows how a city, a county, a state, the federal government, and industry can work together to attack a common problem. Copies are available from the Community Air Pollution Program, Robert A. Taft Sanitary Engineering Center, Cincinnati 26, Ohio.

**Highway officials** . . . . More than 1,700 names, titles, and addresses of administrative engineers and officials in the 48 state highway departments are listed in the ARBA's annual directory. The 1958 edition of the handy pocket-size reference also includes the administrative personnel of the Bureau of Public Roads, the Toll Road Authorities, and the ARBA and its eight organized divisions. Copies, priced at $1.00 each, may be purchased from the American Road Builders Association, World Center Building, Washington 6, D. C.

**Erratum** . . . Through an error that is much regretted the cost of "Multiple Purpose River Development," by John V. Krutilla and Otto Eckstein, was incorrectly listed as $2.00 in the July issue (page 112.) The cost of this 320-page Resources of the Future volume is $4.50 and it is available from the Johns Hopkins Press, Baltimore 18, Md.

## Non—ASCE Meetings

**American Institute of Electrical Engineers.** Fall general meeting at the Penn-Sheraton Hotel in Pittsburgh, Pa., October 26-31. Information from A. A. Johnson, general chairman, AIEE, 33 W. 39th St., New York 18, N. Y.

**American Institute of Steel Construction.** Thirty-sixth annual meeting, Greenbrier Hotel, White Sulphur Springs, W. Va., October 27-31. Information from AISC, 101 Park Ave., New York 17, N. Y.

*(Continued on page 138)*

*Section of 90" concrete pipe is swung into place easily and quickly*

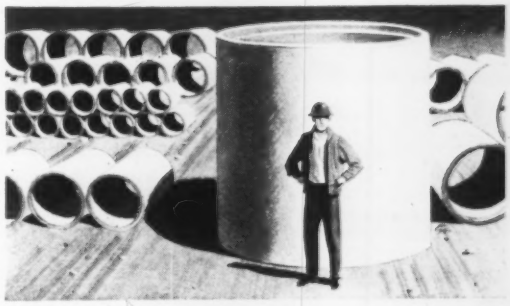
*For Chicago's newest sewers . . .*

# concrete pipe provides maximum strength, greater capacity!

To alleviate street and basement flooding, Chicago is carrying out a multi-million dollar enlargement of its combined sewer system.

On the new Roscoe Street section, 12,500 feet of concrete pipe, 36" through 90" I.D., was used. Placed deep underground—an average of 27 feet for the 90" size—the pipe carries backfill and traffic load without further support. (A real time and economy advantage, too!) And resistance of the pipe to the overburden will increase because concrete gains strength year by year.

And maximum hydraulic capacity is provided by the smooth inner surface of concrete pipe. It resists abrasive wear. Concrete sewers, too, ensure minimum infiltration and leakage. Match all this with moderate first cost and you see why concrete pipe has a long record of solving difficult sewer problems for hundreds of municipalities.



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*General Contractor:* Depot Construction Corp., New York City

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- Underpin 4 old buildings through wet running sand to rock, using Pretest cylinders.
- Install sheeting and bracing systems along buildings.

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## NON-ASCE MEETINGS

(*Continued from page 136*)

**American Public Health Association.** Eighty-sixth annual meeting, St. Louis, Mo., October 27-31. For information and hotel registration write the APHA, 1790 Broadway, New York 19, N. Y.

**American Society of Mechanical Engineers.** Twenty-third National Exposition of Power and Mechanical Engineering, New York Coliseum, New York City, December 1-5. For information write E. K. Stevens, 480 Lexington Ave., New York 17, N. Y.

**American Society for Metals.** Fortieth National Metal Exposition and Congress, Hotel Pick-Carter, Cleveland, Ohio, October 30-31. For information write R. W. Gibson, Jr., Assistant Chief, Information Management Division, Battelle Memorial Institute, Columbus, Ohio.

**Building Research Institute.** Conference on Field Applied Paints and Protective Coatings, Shoreham Hotel, Washington, D. C., December 3-4. Information available from the Division of Engineering and Industrial Research, National Academy of Sciences, National Research Council, 2101 Constitution Ave., Washington 25, D. C.

**Department of Health, Education and Welfare.** National Conference on Air Pollution, Sheraton-Park Hotel, Washington, D. C., November 18-20. For information, write to J. E. Burney, Surgeon General, Public Health Service, Washington 25, D. C.

**Illinois Institute of Technology.** Fourth Annual National Construction Industry Conference, Sherman Hotel, Chicago, Ill., December 10-11. For information write Conference chairman R. T. Mijanovich, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

**Institute of Traffic Engineers.** Annual Convention at Miami Beach, Fla., November 10-13. Information from the Institute, 2029 K Street, N. W., Washington 6, D. C.

**International Road Federation.** Third World Meeting, Mexico City, October 26-31. Information available from the I.R.F., 1023 Washington Building, Washington 5, D. C.

**National Safety Council.** Forty-Sixth National Safety Congress and Exposition, Hotels Conrad-Hilton, Congress, Morrison and La Salle, Chicago, Ill., October 20-24. For information write R. L. Forney, Secretary, NSC, 425 N. Michigan Ave., Chicago 11, Ill.

**National Slag Association.** Forty-first annual meeting, Mayflower Hotel, Washington, D. C., October 21-22. Information from the Association, 613 Perpetual Building, Washington 4, D. C.

(*Continued on page 141*)

# For the world's tallest dam... penstocks of Lukens "T-1" Steel

- Minimum yield strength: 100,000 psi.

Impact strength: sustains Charpy tests at 15 ft.-lb., −50° F.

Weldability: manual or automatic, in the field as well as the shop.

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## Men Available

STRUCTURAL/SOILS ENGINEER. A.M. ASCE, B.S.C.E., M.C.E., P.E., 30, single. Seven years' structural engineering experience, including bridges; concrete and steel-framed buildings; industrial, waterfront and airbase structures; power plants; soil testing specifications and analysis; and equipment foundations. Two years as assistant project engineer. Will travel and/or relocate. C-380.

CHIEF ENGINEER. A.M. ASCE, B.C.E., 37. Five years as engineering consultant; five years as chief engineer on petroleum terminal construction and operation; four years as field engineer and marine construction superintendent. Desire permanent position with responsibility. Location immaterial as long as English language schooling is available. C-381.

STRUCTURAL DESIGN, J.M. ASCE, B.S.C.E., 27. One year of structural design and detailing for timber fabricator. Location desired, Midwest or Northeastern U.S. C-382.

BUILDING CONSTRUCTION ENGINEER. M. ASCE, registered P.E., New York State. Forty years' experience in various types of buildings, including hospitals, office buildings and department stores, both new and altered, thorough knowledge of costs and subcontractors. Available as office engineer or liaison with architect or owner. Will consider part time. C-383.

CONSTRUCTION ENGINEER, JM. ASCE, B.S.C.E., 23. Two years' experience in the design of pile foundations, formwork, sheetpile bulkheads, and offshore platforms. Officer on active duty with U.S. Army Corps of Engineers. EIT Certificate from State of New York. Location desired, foreign or domestic. C-384.

CONSTRUCTION ENGINEER, J.M. ASCE, B.C.E., with honors, 30. Two and one half years of drafting and designing concrete structures; five and one half years on building layout; supervision small jobs to one-quarter million, negotiated and supervised subcontractors. Location desired, New York Metropolitan area. C-385.

EXECUTIVE CONSTRUCTION, A.M. ASCE, 38. Eighteen years' experience residential, commercial, industrial, slipform, feedmill, all phases, preliminary design to completion, foreign and domestic. Has been vice president and president. Internationally travelled. Seeks responsible position Hawaii, Puerto Rico, California, Florida. C-386.

STRUCTURAL DESIGNER, J.M. ASCE, M.S.C.E., 30. Five years' experience, structural design for buildings. Registered professional engineer. No preference as to location. C-387-906-Chicago.

## Positions Available

PROJECT ENGINEER, Earth Dams; graduate civil, with P.E. license, to take charge of design of several small earth dams. Experience in channel work, heavy civil works, and general hydraulic work required. Flood control and field work desirable. Permanent. Location, Massachusetts. W-6418.

LANDSCAPE ARCHITECT with extensive responsible Air Force master planning experience. Will take charge of the master planning of five air bases in Mediterranean area. Headquarters, Italy. F-6426.

INDUSTRIAL WASTE ENGINEER of service engineer caliber, D.Sc., or Ph.D. in sanitary engineering; B.S. and M.S. in chemical engineering with strength in mathematics desirable. No industrial experience required. Primary interest, training, and ability must be in industrial waste disposal instead of water supply and treatment or sanitation. Will advise and guide plant management, operating and technical personnel, in materials conservation and solution of waste disposal problems; negotiate with pollution control agencies, etc. Must be flexible with respect to assignments and free to travel as necessary. Headquarters, East. W-6432.

REGISTERED ARCHITECT, with at least five years' professional experience, to perform Air Force installations work. Salary, $10,200 a year, plus $150 per month living allowance; transportation provided, plus other allowances. Location, Mediterranean area. F-6456.

CIVIL ENGINEERS. *(a)* Project Manager, graduate civil, with at least twenty years' supervisory hydroelectric engineering and construction experience covering high-arch dam, tunnels and power plant facilities. Salary, $20,000-$25,000 a year. *(b)* Project Engineer, civil graduate, with at least ten years' experience covering administration of construction contracts for major hydroelectric projects including surveys and investigations. Salary open. Location, Middle East. F-6469.

PROFESSOR AND HEAD FOR CIVIL ENGINEERING DEPARTMENT, preferably with broad teaching and engineering training, to take charge of program at technical institute. Two-year contract. Salary open. Location, Middle East. F-6470.

CONSTRUCTION ENGINEER, preferably civil graduate and/or mechanical, who has worked for contractors; must have proven record of supervising labor on process and power piping and equipment installations. Salary, $6,500 a year base, plus $70 weekly living allowance when assigned to a job; yearly bonus. Headquarters, Connecticut. W-6479.

CHIEF CIVIL ENGINEER, registered engineer, with sanitary and hydraulic experience; flood control experience desirable; must also be capable of running site work, road and plant utility work. Should be proficient in client contact; able to handle preliminary negotiations and carry a job throughout, design, cost estimates, reports and supervision of construction. Apply by letter giving full details including salary requirements. Headquarters, New England. W-6482.

ASSISTANT MATERIALS ENGINEER, graduate civil or chemical, with at least five years' experience in the testing of asphalt, concrete, and other construction materials. Some experience with bituminous products desirable. Salary, $6,500 a year to start. Location, Massachusetts. W-6485.

SALES ENGINEER, construction and engineering training required, to expand acceptance, specifications, applications by engineering firms of established waterproofing and corrosion-protection specialties. Considerable traveling throughout U.S. Headquarters, New York, N.Y. W-6494.

SUPERINTENDENT OF STREETS, graduate civil engineer with practical and demonstrated effectiveness in the field of public works, including the care and maintenance of streets, sewers, sidewalks, motor equipment, snow removal, ash, paper and garbage collection. Position is with a community of approximately 60,000 inhabitants. Salary, to start, $10,000 a year. Location, Massachusetts W-6499.

ENGINEERS. *(a)* Civil Engineer, graduate, with at least five years' professional experience in water, sewer and highway design. Short-term contract. Salary open. *(b)* Structural Engineer with experience as estimator and specifications writer in structural, civil and mechanical engineering. Salary, $9,996 a year, plus $150 per month living allowance; transportation provided and medical, dental, PX and commissary privileges authorized. Contract for a minimum of one year. Location, Mediterranean area. F-6501.

CONSTRUCTION ENGINEER, civil graduate, with structural steel and reinforced concrete design, specification and field engineering experience covering industrial buildings, tunnels and heavy construction. Salary open. Must be U.S. citizen. Location, Midwest. W-6503.

INSTRUCTORS OR ASSISTANT PROFESSORS to teach courses in electrical engineering, mechanical engineering, civil engineering, mathematics or physics. Some teaching experience desired. Salaries open. Location, New England. W-6505.

ENGINEERS. *(a)* Sanitary Engineer with several years' experience as an engineer and chemist in the field of water supply. Salary commensurate with experience and ability. *(b)* Water Supply Engineer, graduate civil, with some distribution-system experience including supervision, design, construction, and operation. Must be capable of assuming responsibility and progressing in this field with a growing organization. Salary commensurate with ability. Applicants apply by letter giving complete information as to education, previous employment, salary requirements, etc. Location, New York Metropolitan area. W-6509.

ENGINEERING OFFICE MANAGER for architects and engineers; engineering graduate, plus business experience; with ten to twenty years' experience in an architect's and engineer's office preparing report preparation. Must know how to supervise accounting and render financial reports; visit with clients and represent company on business matters. Salary, about $12,000 a year. Headquarters, Athens, Greece. F-6516.

RESIDENT PROJECT ENGINEER. Hydro plant, college degree, with engineering and construction background with minimum of ten years' experience in a responsible capacity on the construction of hydroelectric plants. Must have working knowledge of dam design requirements and construction experience on concrete dams. Will act as resident project engineer to verify that the project is constructed in accordance with designs, plans, and specifications prepared by design engineer; review engineering and design planning schedules, detailed construction schedules, cost estimates, etc. Salary commensurate, with past earnings and experience; transportation expenses and quarters allowance paid. Duration, approximately 24 months with possibility of a one-year extension. Location, Far East. F-6517.

CIVIL ENGINEER with extensive experience in the design and construction of large-capacity water supply projects including pumping stations and intake structures. Apply by letter including a complete résumé and salary requirements. Employer will negotiate placement fee. Location, upstate New York. W-6520.

ESTIMATOR AND CONSTRUCTION ENGINEER, graduate civil, for a young aggressive firm doing general construction, industrial, commercial, and institutional work. Three to five years' experience required. Opportunities and benefits. Location, southeast Ohio. W-6528.

DESIGN ENGINEER, B.E.C.E., two years' experience in reinforced concrete, know structural design. Duties will be reinforced concrete design and detail. Drawings for same following existing drawings for methods and procedures. Will do some structural steel design, but normally no detailing for a contractor and engineer. Salary, $8,400-$9,600 a year. Employer will pay placement fee. Location, Kansas. C-6967.

SALES-CONTRACTOR EQUIPMENT, C.E. or M.E. or equivalent, minimum of five years' direct sales of machinery, accessories, and equipment to contractors, municipal county, state; know people, applications, problems and answers, develop territory with great potential. Salary, $12,000-$15,000 a year. Location, San Francisco East Bay. S-3805.

EXECUTIVE SALES ENGINEER-CONSTRUCTION EQUIPMENT, preferably graduate engineer. Thoroughly familiar with heavy engineering contractor operations; well acquainted with top men in California construction industry and with not less than five years' direct sales experience. Staff position; territory unrestricted, travelling long hours, executive contact and entertain. Salary $15,000-$20,000 a year. Location, San Francisco. S-3807.

# RECENT BOOKS

*(added to the Engineering Societies Library)*

**Building with Tilt-Up**
Second Edition

A field manual describing the various procedures utilized in this type of construction, including floor-slab fabrication and crack control; wall-panel fabrication; hot and cold weather concreting; wall footings and special foundations; panel pick up; erecting and bracing; joinery. This edition contains a special section on the custom modular-framing method useful for special buildings, such as schools. (By F. Thomas Collins. Know How Publications, P.O. Box No. 488, Eugene, Ore., 1958. 160 pp., paper, $10.00.)

**Composite Construction in Steel and Concrete for Bridges and Buildings**

The fundamentals of composite construction are given, including design equations and procedures, methods of connecting slabs to beams, and illustrative examples of design procedures. Special features include a rapid method for the composite design of beams, and design methods for the three most commonly used shear connectors, studs, flexible channels, and spirals. (By Ivan M. Viest and others. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1958. 176 pp., bound, $7.50.)

**Design and Construction of Asphalt Pavements**

Discusses such aspects as types of asphalt pavements, petroleum asphalts, mineral aggregates, design and construction of hot-mix asphaltic concrete pavements, asphalt pavements and bases employing liquid asphalts, surface treatment and seal coats, and reconstruction of old pavements. A feature of the volume is the appendix on laboratory-mix design of asphaltic concrete. (By J. Rogers Martin and Hugh A. Wallace. McGraw-Hill Book Company, Inc., New York 36, N. Y., 1958. 305 pp., bound, $11.50.)

**Estimating Construction Costs**
Second Edition

A practical text outlining various methods of preparing estimates. This edition has been expanded to include more information on bonds, insurance, and depreciation of equipment, as well as new information on stone masonry, house carpentry, interior finish, millwork, wallboard, lathing, plastering, painting, glass, glazing, roofing, plumbing, and electrical wiring. Cost data have been brought up to date throughout. (By R. L. Peurifoy. McGraw-Hill Book Company, Inc., New York 36, N. Y., 1958. 446 pp., bound, $10.75.)

**How To Become a Professional Engineer**

The underlying philosophy and practice of engineering are presented, followed by the practical steps to be taken in securing registered status; qualifying experience, how to prepare for and pass the written examination, and registration by endorsement. A summary of state registration laws, names and addresses of state board secretaries, and a list of recommended texts for use in preparing for examinations are given. (By John D. Constance. McGraw-Hill Book Company, Inc., New York 36, N. Y., 1958. 272 pp., bound, $6.50.)

**Manual of Accident Prevention in Construction**
Fifth Revised Edition

Beginning with accident prevention organization in general, the manual continues with detailed suggestions for safety in various phases of construction activity. This new edition contains enlarged sections on explosives, concrete construction, scaffolding, power tools, marine equipment, and highway construction. The manual is also available in single sections. (Published by the Associated General Contractors of America, Inc., Washington, D. C., 1958. Various pagings, ring binding. Price not given.)

**Mathematical Programming**

Primarily designed for industrial personnel lacking advanced mathematical training, this volume stresses practical applications of mathematical programming. In addition to an extensive chapter consisting of case studies, material is presented on the distribution method, Vogel's approximation method, the simplex and its formulation, the relaxation method, and the computer as a means of solution. (By Nyles V. Reinfeld and William R. Vogel. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y., 1958. 274 pp., bound, $9.00.)

**Philosophy of Structures**

Discusses the basic concepts of advanced structural design as developed by Eduardo Torroja, the author, including such factors as the nature of stress in different types of structures; the proper use of materials; structural elements; design of retaining structures, roofs, floors, bridges, and aqueducts; construction methods and their influence on design and cost; the role of calculations and experimental stress analysis; the function of the designer in the construction enterprise. (University of California Press, Berkeley 4, Calif., 1958. 336 pp., bound, $12.50.)

**Prestressed Concrete: Theory and Design**

This reference by R. H. Evans and E. W. Bennett is divided into three parts. The first deals with the theory underlying prestressed concrete. Part two covers the design of simply supported beams. Part three gives an introduction to the specialized types of prestressed structures such as composite construction, statically determinate structures, indeterminate structures, liquid-retaining structures, and domes and shells. (John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1958. 294 pp., bound, $10.00.)

**Prestressed Concrete: Theory and Practice**

Discusses structural analysis, design, and current practical procedures; tanks and pipes; bridge deck analysis; deformation of prestressed concrete and transmission length; overload, ulti-

*(Continued on page 142)*

## NON-ASCE MEETINGS

*(Continued from page 138)*

**National Society of Professional Engineers.** Fall meeting, St. Francis Hotel, San Francisco, Calif., October 22-25. For reservations write J. A. Sontheimer, Secretary, California Society of Professional Engineers c/o St. Francis Hotel, San Francisco, Calif.

**Society for Experimental Stress Analysis.** Annual meeting, Sheraton-Ten Eyck Hotel, Albany, N. Y., November 12-14. For information write the Society at P.O. Box 168, Cambridge 39, Mass.

**Washington State Institute of Technology.** Water Resources Conference, State College of Washington, Pullman, Wash., November 6-7. Information available from W. H. Knight, Technical Extension Services, Washington State Institute of Technology, Pullman, Wash.


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## RECENT BOOKS

(*Continued from page 141*)

mate strength and partial prestressing; unit mold and long-line systems; the Lee-McCall, Freyssinet, Magnel-Blaton, Gifford-Udall, and other systems; friction; anchorage stresses; roads and runways. (By P. B. Morice and E. H. Cooley. Sir Isaac Pitman & Sons, Ltd., London, England, 1958. 394 pp., bound, 57s 6d.)

**The Principles and Practice of Surveying**

Volume I: Elementary Surveying (Ninth Edition)

Various revisions have been made in this new edition including sources of maps and surveying information; European-type transits and levels; stadia theory; astronomical data and illustrative problems; circular curves; mine surveying; aerial surveying and photogrammetry. (By Charles B. Breed and George L. Hosmer. John Wiley and Sons, Inc., New York 16, N. Y., 1958. 717 pp., bound, $6.50.)

**Technical Editing**

Presents the basic concepts and practices of internal communications, journal editing, book publishing, and graphic arts as related to the technical field. The papers are written by persons engaged in these activities and provide a practical approach. (Edited by B. H. Weil. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y., 1958. 278 pp., bound, $5.75.)

### Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translations services, and can supply photoprint or microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N.Y.

## Applications for Admission to ASCE, Aug. 9-30

### Applying for Member

WILLIAM MCKINLEY BECK, Norfolk, Va.
JOHN DEMETRIUS COUMOULOS, Athens, Greece
LESLIE COWAN, Columbia, Mo.
WILLIAM DANIEL DARBY, Hales Corners, Wis.
GUY DELANEY, Harrisburg, Pa.
ANDRE PIERRE LOUIS DELFLACHE, Beaumont, Tex.
CHINTAMAN VISHNU DESHPANDE, Bombay, India
CLARENCE HERBERT DROWN, Sacramento, Calif.
ARTHUR GEOFFREY EDWARDS, Middlesex, England
JAMES PATRICK ANTHONY DERRICK FERNANDO, Colombo, Ceylon
OLISSE DANIEL FERRARI, Harrisburg, Pa.
GEORGI GEORGOFF, Baltimore, Md.
ADAM KRUGER GRAFE, Dallas, Tex.
ALBION MATTHEW GRUBER, Sr., Savannah, Ga.
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MCDONALD DONEGAN WEINERT, Austin, Tex.
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JACK HOWE BAYNHAM, Kansas City, Mo.
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WILLIAM HAROLD CANNON, Nashville, Tenn.
JOHN ROBERT CHERRY, Cleveland, Ohio
EDWARD CHOW, Vancouver, British Columbia
CHARLES MILTON COFFLAND, Temple City, Calif.
JOHN PETER DEBBINK, Oconomowoc, Wis.
ROBERT HYDE DEGRANGE, Chicago, Ill.
GUALTIERO DE MARTINO, Johannesburg, South Africa
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EDWARD JOSEPH HYLAND, Chicago, Ill.
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(*Continued on page 143*)


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## APPLICATIONS

*(Continued from page 142)*

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## Positions Announced

**City of Flint.** Equipment and Asphalt Superintendent wanted to work with methods, materials, and equipment in testing laboratory. Salary range: first six months, $7,944; second six months, $8,340; second year, $8,763; third year, $9,118; and fourth through tenth year, $9,487. Applicants must have a degree in either civil or chemical engineering and qualify for Civil Service requirements. Contact Flint Civil Service Commission, Municipal Center, Flint, Mich.

**International Cooperation Administration.** Vacancies for Sanitary Engineers for overseas employment. Salary range: $8,000-13,000, plus housing and other allowances where applicable. Applicants must have degree in either sanitary engineering or public health for subordinate positions, with appropriate experience for positions of more responsibility. Minimum assignment is two years. For information write Public Health Division, Box 100, International Cooperation Administration, Washington 25, D. C.

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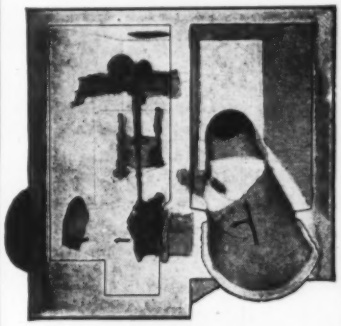

Fig. B-19

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DIETZGEN

### 1 ACKER HILLBILLY CORE DRILL

**Acker Drill Co., Inc.**—offers free of charge, Bulletin 29 which describes and illustrates a lightweight diamond core drill. Two models are available. Hydraulic Feed Model weighs 1050-lb while the Mechanical Screw Feed Drill weighs only 872-lb. Both models have a built-in hoist and can be furnished when desired with a built-in water pump. Depth capacity is 500-ft.

### 2 ADJUSTA-BRACE

**Superior Concrete Accessories, Inc.**—Literature discussing the Adjusta-Brace for quick and positive form alignment is now available. Providing a swivel action for quick positioning and adjustment, the Brace consists of 2 units connected by a 2 x 4, 2 x 6 or a 1-in. i.d. pipe. It is light in weight, durable, and inexpensive. A savings in time and labor compared to the conventional method of bracing has been reported.

### 3 ALL-PURPOSE EARTH AUGER

**Acker Drill Co., Inc.**—will send free of charge a copy of the Bulletin 40-R, describing the all-purpose earth auger, which is a highly versatile and useful unit for developing rock profiles, soil sampling operations, diamond core drilling, and highway test coring. The brochure is profusely illustrated.

### 4 ALUMINUM GRATING

**Borden Metal Products Co.**—A brochure by way of diagrams and photos illustrates the properties and uses of aluminum floor gratings. Also shown are tables of their specifications. A description of safety grating and aluminum safety steps is featured.

### 5 ALUMINUM GRATING

**Kerrigan Iron Works, Inc.**—A new 8-page catalog on three types of aluminum grating, Roll-Lock, Riveted and Pressure-Locked, is now available. It contains load tables and engineering data on all types and in-use illustrations or photographs. Lightweight, non-magnetic, non-corrosive, aluminum grating has no maintenance cost and its high strength insures many years of service.

PLEASE PRINT

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## Mail This COUPON To-day

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Please have the literature indicated by the circled CATALOG DIGEST numbers in the October 1958 issue sent to me without obligation.

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| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8* | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36* | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 |
| 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 |
| 106 | 107 | 108* | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 |
| 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157* | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 |
| 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 |
| 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 |
| 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 |
| 226 | 227 | 228 | 229* | 230 | 231 | 232 | 233* | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253* | 254 | 255 |
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**NOT GOOD AFTER November 15, 1958, for readers in the U. S., but requests will be accepted to December 31, 1958, from readers outside of this country.**

### 6 ALUMINUM GRATING

**Klemp Metal Grating Corp.**—This 4-page brochure describes Klemp's RR (rectangular riveted) Aluminum Grating. Photos of actual installations and applications, descriptions, diagrams, safe load tables and complete specifications are included.

### 7 ALUMINUM GRATING

**Washington Aluminum Co.**—A catalog on Aluminum Grating and the complete Aluminum Fabrication facilities for industry is now available. The grating is non-sparking, non-magnetic and maintenance-free. Its special I-Beam design extrusion gives it superior structural strength, yet it is light in weight. Another feature is that cutouts are flat bar banded by a continuous weld. The grating is available in upset pattern for maximum non-directional, non-skid safety or plain design.

### 8 ASPHALT CURBS & GUTTERS

**The Asphalt Institute**—"Specifications & Construction Methods for Asphalt Curbs & Gutters" combines the features of a popular brochure with the detailed engineering data of a manual. First issued as a popular booklet, the revised edition includes The Asphalt Institute specification with important Notes to the Engineer. An appendix includes the standard FHA specification for this type of construction. The price is $.20.

N. B. There is a charge for this book. Make checks payable to The Asphalt Institute.

### 9 ASPHALT LINER MANUAL

**W. R. Meadows, Inc.**—announces the availability of a "Hydromat" Asphalt Liner Manual. The "Hydromat" Manual fully describes applications and contains installation information, necessary technical engineering data and specification information. This is not a sales catalog, but strictly a Technical Data Manual.

### 10 ASPHALT ROADS

**The Texas Co.**—Step-by-step descriptions of various types of asphalt road and street construction are presented in a 24-page illustrated booklet. The types covered include Asphalt Penetration Macadam, Road-Mixed Asphalt Surfaces and various low-cost Asphalt Surface-Treatments for roads and streets. A series of helpful tables will assist in estimating asphalt and aggregate quantities for projects.

### 11 AUTOCOLLIMATING THEODOLITE

**Kern Instruments, Inc.**—Information is available on the Autocollimation Eyepiece, which when attached to the DKM2 1-sec Theodolite, becomes an integral part of the instrument. Total telescope magnification is 23x, working distance up to 100 ft indoors. The light source is an easily replaceable standard 3-V or 6-V bulb. The instrument can be used for normal surveying without removing the eyepiece by simply switching off the light which illuminates the reticule.

### 12 AUTOMATIC GATES

**Thompson Pipe & Steel Co.**—This catalog illustrates and explains 3 devices which control upstream and downstream water levels and flow without usual floats and supervision. On-the-job photos and diagrams show the many irrigation and water-works applications. These gates are made on the widely-adapted Neyrpic principle.

### 13 AXIAL FLOW PUMPS

**S. Morgan Smith Co.**—This catalog covers both adjustable-blade and fixed-blade axial flow pumps, a high capacity design which provides the most economical method of pumping where large volumes of water under low heads are to be moved. The booklet describes applications, performance characteristics, pump settings, engineering data, detailed specifications, and controls.

## Use This Free Service—Mail The Coupon To-day

# LACLEDE DESIGNED REINFORCEMENT SPEEDS REPLACEMENT OF CONCRETE BRIDGE DECK

A ticklish problem arose in the renovation of MacArthur Bridge, spanning the Mississippi River at St. Louis. Three existing pavement lanes were to be replaced with concrete slabs, reinforced with Laclede Multi-Rib Round Reinforcing Bars. To permit uninterrupted traffic flow over the bridge, the project was to be accomplished a lane at a time.

*the problem:*

Vibration from traffic on a completed lane would be transmitted through the tie-bars, disrupting bond of the reinforcement to newly-poured concrete in the adjoining lane.

*the solution:*

Laclede engineers, cooperating with the Bridge Department of the City of St. Louis and C. E. Smith & Company, consulting engineers, designed special tie-bars with three-inch-wide bands of asphaltic material wrapped around the point where they passed through the center joint. Vibration from heavy vehicular traffic was cushioned and absorbed by these flexible wrappings. Bond of reinforcement to new concrete in the lane under construction remained unaffected during the entire setting and curing period.

General Contractor: Fruin-Colnon Contracting Co., St. Louis.

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**LACLEDE STEEL COMPANY**

SAINT LOUIS, MISSOURI ◆ Producers of Steel for Industry and Construction

### 14 BALL-JOINT COLUMNS

**Industrial Tectonics, Inc.**—A two-page brochure illustrated in color describes the stainless steel balls, up to 11½ in. in diameter and grooved in three directions to hold lubricant, which act as permanent spherical bearings in ball-joint columns. The columns support an elevated structure, move freely with all horizontal deflections of the structure, and are not subjected to high bending stresses.

### 15 BALL-JOINT PIPE

**American Cast Iron Pipe Co.**—In order to familiarize the users of pipe with the merits of the American Molox Ball Joint, this 30-page fully-illustrated brochure contains a detailed description of the joint, valuable suggestions for installing the pipe, dimensions and weights and other technical data.

### 16 BEARING PADS

**Voss**—An illustrated catalog concerning molded Neosorb and pre-formed Sorbtex bearing pads is now available. Especially suited for pre-stressed concrete or steel construction, they give full beam conformation and assure pre-calculated permanent set with limited deflection.

### 17 BOILER AND STOKERS

**The James Leffel & Company**—Complete descriptive and specification information on rugged Scotch boilers for gas, oil and coal firing and automatic underfeed stokers for Scotch type boilers is given in a 28-page bulletin 236. This richly illustrated brochure includes test results, performance data, and complete details of design and construction.

### 18 BORINGS

**Raymond Concrete Pile Co.**—A booklet "Subsoil Investigations for Foundations" Catalog B-7 explains the reason for subsoil investigations, what Gow borings are and how they are made, and the results obtained. Illustrated are methods for making borings and taking samples, and various types of rigs in operation.

### 19 BRIDGE FLOORING

**American Bridge Division**—This 32-page booklet contains complete engineering drawings and design data for all available I-Beam-Lok sizes, plus detailed coverage of Specifications, including the type of steel, erection, fabrication, painting, field assembly and welding. A brief discussion of composite T-beam action between I-Beam-Lok flooring and steel stringers is also included.

### 20 BRIDGE FORMS

**Granco Steel Products Co.**—This booklet contains product description, application data, job photographs and illustrations of the Sip Bridge Forms, which are permanent galvanized steel forms for concrete bridge deck slabs. Eliminating the removal of forms, they are designed to fit permanently over or between stringers. The forms provide a safe working platform of steel, which becomes a part of the finished structure and requires no maintenance, and they eliminate delays while concrete cures and old fashioned forms are stripped, giving faster construction and earlier bridge completion.

### 21 BRIDGE SPECIFICATIONS

**John A. Roebling's Sons Corp.**—This 22-page booklet contains the information required for the selection and preparation of specifications for wire, strand and rope used on guyed structures and suspension systems of all kinds, except major suspension bridges. The four basic sections are: Bridge Strand, Standard Galvanized Bridge Rope, Galvanized Wire and both Standard and Special Fittings.

### 22 BRONZE PRODUCTS

**M. Greenberg's Sons**—The complete line of bronze products described in this catalog includes such items as fire hydrants and industrial valves; bronze valves for Navy, Maritime and industrial use; plumbing specialties; Josam drains and interceptors; and bronze plaques and letters.

### 23 BUILDING SAVERS

**L. Sonneborn Sons, Inc.**—A 16-page brochure of building construction and maintenance data covering the company's water-proofings, floor treatments, admixtures and protective coatings. The product descriptions include definitions, directions, advantages, coverage and specifications. Known as Building Savers, these quality products are the tested solutions to your building construction and maintenance problems.

### 24 CABLETRAYS

**The Globe Co.**—Catalog #8572A on Globetray, ladder type tray, and Cable-Strut, basket type tray, contains complete engineering data as to load data, fabrication, sizes, etc. as used with electrical cables and/or copper and plastic tubes.

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YOUR REQUESTS TAKE TIME


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LOW-COST AUTOMATIC FLOW RECORDING

***Directly Readable Flow Charts***

Obtain graphic records of liquid flow directly readable in million gallons per day or gallons per minute over various sizes of Parshall flumes. The same recorder can also be used with charts reading in feet and hundredths to record head or surface fluctuations in lakes, streams, wells. Write for free Bulletin 24.

STEVENS

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...For Measuring Sewage, Industrial Waste and Other Flows

***The planning and efficient operation*** of any project which involves measurements of flowing liquids is based on flow data which can be obtained with STEVENS Recorders. These instruments are at work compiling data on hydroelectric and flood control projects and in water works, sewage disposal plants, irrigation and industrial installations in all parts of the world.

**Experienced technical staff available to supply product information for liquid measurement installations. Write, giving description of project and scope of data desired.**

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124 pages of technical data on recorder installations, plus a wealth of hydraulic table and conversion tables. $1 copy. (No COD's.

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## Bulkhead and Anchor walls built with Steel Sheet Piling for Pier 1 in Brooklyn

Just south of the Brooklyn Bridge is the Brooklyn-Port Authority's new Pier 1, shown during construction. Solid fill construction is being used, with steel sheet piling used as a bulkhead wall at the water-side. A second sheet piling "deadman" anchor wall is connected by tie-rods to the seawall.

To be a large L-shaped structure, Pier 1 is expected to be completed in 1959. It will have 30-ft wide aprons, 256,000 sq ft of shed space, a 20 ft-wide loading platform to handle 80 trucks, and a 360,000 sq ft paved upland area. An existing pier is being incorporated into the overall plan of Pier 1.

Bethlehem supplied the steel piling for Pier 1 as well as for other important projects in the extensive Brooklyn marine terminal development program.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

**BETHLEHEM STEEL**

BETHLEHEM STEEL

### 25 CAR CATALOG

**Oldsmobile Div., General Motors Corp.**—In beautiful 4-color rendition, the 32-page 1959 car model catalog illustrates all 15 glamorous new Oldsmobile offerings, with complete equipment and accessory information, plus full specifications for each series, Ninety-Eight, Super 88, and Dynamic 88.

### 26 CARPULLERS

**Superior-Lidgerwood-Mundy Corp.**—A 24-page, 2-color bulletin C-616 "Carpullers for Easy Moving Rolling Loads" has been issued, with descriptions, illustrations, data, tables and specifications for Carpuller requirements. Illustrates and describes the Electric Capstan Carpuller for car moving, barge moving, pipe bending or any haulage of similar nature; also Tugmore Capstans, Horizontal Head type Capstan Carpullers, Drum Type Carpullers, Friction Drum Type Carpullers, etc.

### 27 CAST IRON PIPE

**Cast Iron Pipe Assoc.**—A booklet on the flow capacity of cast iron pipe is now available. It includes flow tables based on the Williams-Hazen Formula.

### 28 CAST IRON PIPE

**U. S. Pipe & Foundry Co.**—An 8-page booklet on centrifugally cast, Tyton Joint pipe for water or other liquids. The newly developed Tyton Joint is simple, sturdy, and tight. Illustrations show details of joint and method of assembly.

### 29 CAST IRON PIPE, HYDRANTS AND VALVES

**R. D. Wood Company**—A general catalog has been issued providing full details of weights and dimensions of "sand spun" cast iron pipe and cast iron fittings. This catalog also features fire hydrants, gate valves and other products manufactured by this company.

### 30 CEMENT LININGS

**Centriline Corp.**—The Centriline Process for cement mortar lining steel, cast iron, concrete and terra cotta pipelines in place and which has been available in the diameters 16 in. to 144 in. can now be used in pipelines as small as 4 in. in diameter. This new adaptation of the Centriline Process for small pipelines eliminates the necessity for excavations at laterals and corporation cocks and is fully described in the new illustrated catalogue.

### 31 CHAIN LINK FENCING

**Aluminum Company of America**—A new 16-page booklet outlining the many advantages of aluminum chain link fencing in the highway, industrial and municipal and public agency markets has been published. Text material is relatively brief and the brochure contains many illustrations of actual applications of aluminum fencing. In addition, tabular data and charts based on published ASTM test results are included to document the performance of aluminum fencing in various industrial and sea coast atmospheres.

### 32 CHAIN LINK FENCING

**Aluminum Company of America**—A new six-page fold-out brochure of suggested standard specifications for aluminum chain link fence is now available. It contains complete description of fabric, fasteners, braces, posts, rails, and post tops, and it suggests specifications for alloys, with alloy designation of ASTM. Typical details of components are also pictured.

### 33 CLAD STEEL BRIDGE BEARING PLATES

**Lukens Steel Company**—A discussion of the development of Lukens clad steel for bridge bearing plate applications together with a description of types of plates presently available.

### 34 CLAD STEEL EQUIPMENT

**Lukens Steel Company**—A description of the development and manufacture of Lukens clad steels including data on types of cladding, cladding thicknesses, testing, clad steel heads, fabricating clad steel and various clad steel applications.

### 35 CLAY PIPE

**National Clay Pipe Manufacturers, Inc.**—This 48-page fully illustrated brochure entitled "The Story of Clay Pipe" contains an historical record of clay pipe, its contribution to America from the beginning of the 20th century to the present, and a look into the future of American homes, industries and communities.

### 36 COFFERDAMS

**Spencer, White & Prentis, Inc.**—"Cofferdams," by Lazarus White and Edmund Astley Prentis is a trusted source-book covering actual design and construction of cofferdams as well as the theoretical features. The price is $10.

N. B. There is a charge for this book. Make checks payable to Spencer, White & Prentis, Inc.

### 37 COMBINATION GRADER AND VIBRATORY COMPACTOR

**Galion Iron Works & Mfg. Co.**—Leaflet No. 424 describes how you can grade and compact with one machine. This unit is a combination of the Galion Model 503 Motor Grader and a Jackson Electric Vibratory Compactor. This combination will meet most density specifications for granular soil normally used for base and subbase construction.

### 38 COMPACTION EQUIPMENT

**The Galion Iron Works & Mfg. Co.**—An informative, well-illustrated, non-technical, 16-page pamphlet covering all types of rollers and other compaction equipment has been published. This treatise will be especially helpful to anyone who has previously had no opportunity to study the subject of soils and materials compaction, the problems encountered, and the application of the various types of equipment available.

### 39 COMPLETE FABRICATION FACILITIES

**Washington Aluminum Co., Inc.**—This catalog shows the many unusual aluminum fabrications for industry. Among the fabrication assignments have been: water and sewage equipment, rigid and suspension bridges, tanks, hoppers, structures for loading platforms, buildings, cranes, and special applications. The company also offers assistance in resolving aluminum fabrication problems for industrial use, at no obligation.

RETURN THE COUPON TODAY FOR IMMEDIATE RESULTS!

DID YOU MAKE YOUR CHECKS PAYABLE TO THE PROPER COMPANIES?


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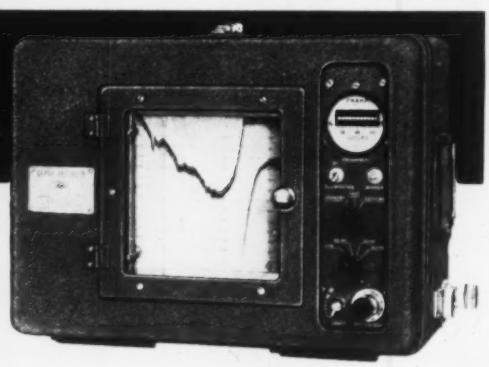
**Model 255A SURVEY DEPTH RECORDER**



Edo Model 255A Survey Depth Recorder, designed expressly for underwater dredging and cable laying operations, employs an extremely narrow beam pattern (6° at −10 db) to obtain precise, detailed contour information. High operating frequency, 110 kc, minimizes penetration of silt or mud with the result that the recorder accurately pictures the soft bottom that is of concern in dredging.

Also available is Edo's Model 255B Survey Depth Recorder, with standard beamwidth (20° at −10 db), the ideal equipment for deep depth, penetration and general survey. With dual beam transducer, Model 255B can increase beamwidth to 40° at −10 db.

Edo Models 255A and 255B are both manually adjustable for transducer draft or sound velocity and record in eight overlapping ranges, 0 to 250 fathoms.

*For illustrated brochures, write Dept. V-10*

Edo CORPORATION, College Point, L. I., N. Y.

# CATALOG DIGESTS

### 40 CONCRETE CONTROL FACTS

**The Master Builders Co.**—Facts about Pozzolith for improving control of concrete properties are described in a well indexed 16-page booklet. An explanation of how it controls water content, rate of hardening and entrained air in concrete and the beneficial effect of these controls on concrete in both the plastic and hardened state are outlined. Information for obtaining consultation or further reports on the use of Pozzolith in specific jobs is also given.

### 41 CONCRETE FORMING SYSTEM

**Economy Forms Corporation**—A catalog with pictures is offered showing a complete forming system available to contractors on a purchase basis. The easy adaptability of these forms to all types of form work, plus engineering layout service on each new project, together with a complete steel form good for a lifetime of service makes the new EFCO form an attractive investment for the large and small builder. Also available, a four-page leaflet covering forms for prestressed or precast concrete beams, etc.

### 42 CONCRETE FORMS & ACCESSORIES

**Universal Form Clamp Co.**—has prepared a 56-page catalog which illustrates and describes their complete line of concrete forms, form ties, accessories, construction specialties and highway products. The catalog makes a handy reference guide for anyone engaged in the forming of concrete.

### 43 CONCRETE PIPE

**Vulcan Materials Co.**—The brochure gives all specifications, photographs of products in use in major pressure and non-pressure installations and other data regarding this high strength, durable, precision-made, economical concrete pipe. Cores cut from Cen-Vi-Ro pipe have tested as high as 13,440 lb per sq in. It fully meets or exceeds requirements of ASTM designation C-76-57T, AASHO designation M170-57 and AWWA specification C302-57.

In filling out the coupon, please print clearly and be sure that you furnish a complete address.

### 44 CONCRETE PRECISION BUMP CUTTERS

**Concut Sales, Inc.**—A 2-page catalog illustrates and describes the concut precision bump cutter which quickly and efficiently eliminates bumps from concrete and asphalt surfaces within the tolerance of $\frac{1}{8}$-in. deviation in 16-ft. It also develops varying degrees of surface texture by adjusting the width of the spacers between the diamond blades.

### 45 CONCRETE RESURFACING

**Portland Cement Association**—This pamphlet is divided into two sections—design of resurfacing and construction of resurfacing. A few of the topics covered are: design of distributed steel, design of widening, design of concrete mixes, preparation of old slab, preparation for widening, and forms and form setting. Single copies distributed free only in the U. S. and Canada.

### 46 CONCRETE SAWING EQUIPMENT

**Concut Sales, Inc.**—A bulletin illustrates and describes the complete line of Concut Concrete Sawing Machines, Supreme Diamond Blades and Abrasive Blades. Included in the line is the Model R-85 Lightweight machine for sawing concrete up to 3-in. in depth, Model-S-200 Standard machine for sawing up to 5-in. in depth, the Self-Propelled Concut and the Jointmaster for large air base and highway sawing jobs.

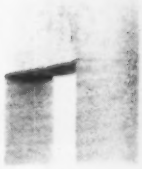

**Reinforced round concrete piers support elevated expressway!**

Overpass piers on new US 41 Expressway near Kenosha, Wisconsin. Wisconsin State Highway Dept., engineers. Linnan Construction and Engineering Company, contractors.

Time-saving, money-saving

**SONOCO Sonotube® FIBRE FORMS**

were used to construct the piers



See us at the ASCE Show Booths 34-35 Statler-Hilton Hotel Oct. 13-17

Another success story for Sonotube Fibre Forms! In this case, the piers formed are 30" and 36" in diameter and range from 14' 6" to 17' high.

But whether the structure is an overpass, bridge or building, contractors everywhere have learned that Sonoco Sonotube Fibre Forms provide the fastest, most economical method of forming round columns of concrete.

Sonotube Fibre Forms take less time to erect, require minimum bracing and are easy to strip. Because of their versatility, low cost and easy handling, these fibre forms save time, labor and money!

Order Sonotube Fibre Forms for your next job . . . sizes from 2" to 48" I.D. in standard lengths of 18 feet. Can be sawed to required length on the job. Available in other lengths to 48 feet if required.

The patented "A" Coated Sonotube Fibre Form is the standard for finished columns. A premium form, Seamless Sonotube (pat. pend.), and a wax-coated fibre form are also available.

*See our catalog in Sweet's*

*For complete information and prices, write*

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**SONOCO Construction Products**

3294 **SONOCO PRODUCTS COMPANY**

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To meet the challenge of today's record engineered construction boom means a never ending search for new and improved construction equipment, installed equipment, materials and supplies. Civil engineers who influence, specify, and buy for engineered construction read the advertisements in CIVIL ENGINEERING because they contain information of value to them in their work.

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**Important Facts from two Studies by the Construction Division of The American Society of Civil Engineers**

1. American Society of Civil Engineers members are dominant in all fields of engineered construction—26 major types of projects specifically mentioned.
2. One or more of almost all types of construction equipment are used by Civil engineers on these construction projects.
3. Civil engineers have a major influence in the specification of practically all construction material and installed equipment required to complete the 26 major types of projects.
4. Civil engineers are highly brand conscious and have definite brand preferences for virtually all construction materials and equipment.
5. Civil engineers hold important executive positions and have responsible charge of work in all areas of construction.
6. Civil engineers consult frequently and extensively with their opposite numbers in other organizations in the process of specifying and buying.
7. Civil engineers hold important positions in contractor organizations and select or directly influence the purchase of equipment.
8. Civil engineers in consulting or awarding agencies also influence equipment purchases.
9. Civil engineers spend almost twice as much time reading their Society magazine, CIVIL ENGINEERING, than any other business publication.

*Engineers are educated to specify and buy!*

# CIVIL ENGINEERING

*Published by* *The American Society of Civil Engineers*
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# ES 130 SURVEY DEPTHOMETER

For salvage, submarine survey and channel inspection . . . all-purpose. Completely portable, lightweight . . . four scale ranges 0/65 feet, 60/125 feet, 120/185 feet and 180/245 feet. Accuracy ½ of 1%. Operates on 6 or 12 volts DC or 115 volts AC. Single transducer. Base price **$1175.**

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Completely portable 3-unit Closed Circuit TV specially designed for depths to 180 feet. Diver holds camera (approx. 4 lbs. submerged) relays continuous high definition picture to Monitor screen on boat or land. Complete with surface Control Unit. Approx. **$4,000.**

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## SYMPOSIUM ON ROCKFILL DAMS

DURING the June 1958 Portland (Oregon) Convention of ASCE, the Power Division sponsored a series of papers which comprise a Symposium on Rockfill Dams. These eighteen papers and three papers on the same subject from former ASCE meetings, have now been gathered into a single volume. These papers present the design, construction, and maintenance problems encountered on rockfill dams in the United States and in other countries.

*If you desire to obtain a copy of this 500-page volume, use should be made of the accompanying order form.*

---

**American Society of Civil Engineers**
**33 West 39th Street, New York 18, New York**

Please send me.....copy(s) of the Symposium on Rockfill Dams (Proc. Symp. Series No. 3) at a list price of $8.00 each (50% discount to members of ASCE).

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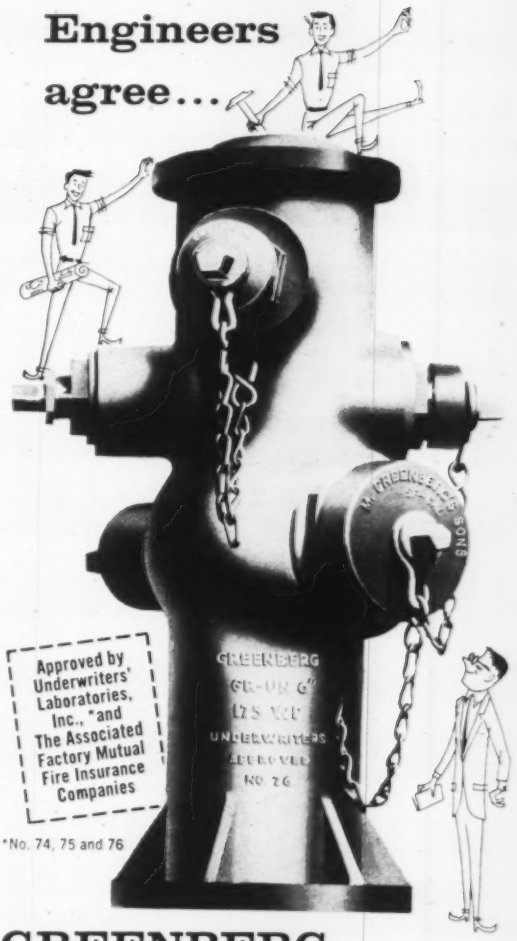
CITY .....ZONE.....STATE.....



# Engineers agree...

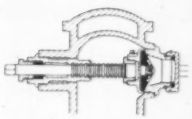



# GREENBERG

## California type HYDRANTS are preferred everywhere!

The most widely preferred design throughout the Western States, Panama, South America, Hawaii, the Philippines, South Pacific and Saudi Arabia. These improved hydrants have received the endorsement of fire chiefs, waterworks superintendents and engineers everywhere.

**SPECIFICATIONS**



- FAST BREAKING VALVE DESIGN
  Seat angle provides maximum efficiency, minimum resistance, quick opening and full flow of water. Eliminates water hammer and valve chatter at full 200 lbs. working pressure.
- Independent valve for each outlet
- Full 6¼" waterway
- Curved deflector head—assures full pressure by reducing friction.
- Simple construction. All bronze working parts and heavy cast iron body give long, trouble-free service.

We also manufacture a complete line of industrial and maritime bronze valves and fittings, plumbing specialties, hose goods, hardware, plaques, tablets and letters.

Please send for your free copy of our Catalog T.

BRONZE PRODUCTS
by M. GREENBERG'S SONS
765 Folsom St. • San Francisco, Calif. • EXbrook 2-3143
Offices in Principal Cities throughout the United States

### 47 CONCRETE TESTING EQUIPMENT

**Forney's Inc., Tester Div.**—The manufacturer offers a series of twelve single page circulars describing a complete line of low cost plant and jobsite testing machines for cylinders, cubes, beams, blocks, pipe, tile and lintels. Data on Cylinder Capping Apparatus, Kelly Balls, Slump Cones, Cube Molds and other collateral apparatus is included.

### 48 CONCRETE WATERSTOPS

**Water Seals, Inc.**—Labyrinth[R] Waterstops are manufactured of polyvinyl plastic, which helps maintain a constant, strong, watertight bond between concrete joints. This catalog describes the convenient features of Labyrinth[R] Waterstops, including those which render it resistant to age, chemical and weathering changes. Blueprint type specification drawings include the Labyrinth, Flextrip, Cellular and Dumbbell waterstops in their various sizes. A table lists the recommended joint application and water head for each size and kind of waterstop.

### 49 CONCRETE WATERSTOPS—STANDARD & PREFABRICATED

**Water Seals, Inc.**—Labyrinth[R] Waterstops, manufactured of durable polyvinyl plastic, have the ability to maintain a constant watertight bond between concrete joints, are available in either fabricated form for special application or in standard linear form. This catalog describes the recommended applications for each of the various types of waterstops, including maximum water heads, specific joint applications.

### 50 CONDENSATION RETURN UNITS

**Aurora Pump Div., The New York Air Brake Co.**—Bulletin 114 has complete information about the Type C Condensation Return Units for 500 to 150,000 sq ft EDR and 10 to 125 psi. Included are applications, cut-away drawings, selection tables, dimension prints and specifications.

### 51 CONSTRUCTION & ENGINEERING FUNCTIONS

**Macco Corp.**—Offered free of charge is a descriptive brochure containing thumb-nail sketches of the functions of the company's diversified divisions and subsidiaries. Included are the Construction Division; Diversified Builders, Inc.; Pipeline Division; Lumber Division; Refinery & Chemical Division; Belyea Truck Co.; Pacific Crane & Rigging Co.; Pacific Dredging Co.; Rig Building Division; and the Drilling Fluid Division.

### 52 CONSTRUCTION EQUIPMENT

**International Harvester Co.**—Some of the equipment listed in this pamphlet are: crawler tractors, blades, scrapers, payhauler, payscraper, skid-shovels, and sidebooms. Photographs and brief specifications are included.

### 53 CONSTRUCTION REQUIREMENTS

**Connors Steel Div., H. K. Porter Co.**—Manufacturers of cold finished, merchant and reinforcing bars, hot rolled strip, steel posts, angles and channels, sub-purlins, and industrial track work, this company will supply construction requirements as needed.

### 54 CONTRACT PUMPING

**American Dewatering Corp.**—A well illustrated catalog describing the predraining of many construction projects of typical and unusual interest. Outlines the services and benefits of contract pumping in which this company specializes.

### 55 COST DATA

**Barco Manufacturing Company**—Of interest to earthmoving contractors is a bulletin of cost data for soil compaction in restricted areas. Specifications accompany the data.

### 56 CRAWLER TRACTOR

**Allis-Chalmers Mfg. Co.**—Operating advantages and engineering features of the HD-6 Diesel powered crawler tractor are described in a new 14-page catalog (MS-1251). With HD-6E specifications included, this literature brings up-to-the-minute HD-6 crawler tractor information to the reader. Numerous graphs and charts, catalog views of the tractor's principal components and a cutaway view of the entire tractor help the reader visualize the text matter of the brochure.

### 57 DAM CONSTRUCTION & MAINTENANCE

**Intrusion-Prepakt, Inc.**—The 12-page Prepakt Reporter describes how the company's specialized services overcome problems encountered in dam construction and repair. Included is a reprint of the article, "Closing the Sluiceways at Chief Joseph Dam." The entire issue is well illustrated.

### 58 DEGRITTING CLARIFIER & CLARIGESTER

**Dorr-Oliver, Inc.**—A 4-page, two color bulletin, No. 6412, describes the design, operation and advantages of a new degritting device adaptable to both primary Clarifiers and the Dorr Clarigester. Entitled "The Degritting Clarifier & Clarigester", it also includes installation photographs and sectional elevation drawings of typical grit handling facilities of this new design.

### 59 DENSION CORE BARREL

**Acker Drill Co., Inc.**—offers free of charge, a copy of Bulletin 1100, which describes the new improved Dension Core Barrel. Acker has obtained exclusive manufacturing rights to the tool. The brochure illustrates and describes how the core barrel operates. The cutaway drawing of the barrel shows all of the important operational features.

### 60 DEPTHOMETER, CAMERA, LOCATOR

**Bludworth-Marine**—Literature describing the single transducer survey depthometer ES 130, which is portable, weighs under 40-lb and performs with great flexibility and precision, is available. Also provided is information on an underwater TV camera with a continuous picture on monitor screen on boat or land, with depths to 180-ft; and a metal locator which pinpoints ferrous and non-magnetic metals in fresh and salt water. Pressurized to depths up to 160-ft, this locator weighs 1½-lb submerged.

### 61 DESIGN MANUAL

**W. R. Meadows, Inc.**—has prepared a manual entitled "Design Techniques for Controlling Moisture in Building Structures." This manual, prepared by a firm of technical engineering writers, was originally planned to sell for $1.00 per copy. However, as this problem is of vital interest to all in the construction industry, this company will now send a free copy to all architects, engineers and builders who desire a copy for their file.

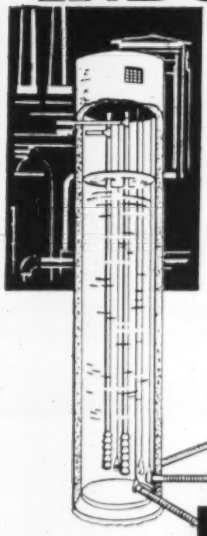
### 62 DESIGNING WAREHOUSES WITH V-LOK

**Macomber, Inc.**—This 20-page, illustrated brochure about V-Lok interlocking structural members includes typical framing plans of two bay sizes, and a diagram of a sidewall sections to help design any type of warehouse required. Three other brochures on V-Lok concerning computer platforms, school construction, and the reduced time and cost of V-Lok, are also available.

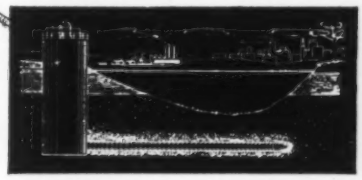
Please give your complete address.

IT'S LIGHTER!
No wood parts.
Double Lock Knobs Close 5-inch Long Collet For 360-Degree Grip On Leg Extension
Shipping Wt. 10 lbs.
PRICE $67.00
DEALER INQUIRIES INVITED
NEW
ALL ALUMINUM
TRIPOD
PRECISION ENGINEERED FOR HEAVIEST DUTY, THE ALL NEW
The Safe-Lock WELT MODEL W-1000
ENGINEERS EXTENSION TRIPOD
At last an entirely new Engineers' tripod replacing the ordinary heavy troublesome wood and bronze tripods! Much easier to carry and set up . . . actually weigh 4 to 5 pounds less than old style tripods. Needs no maintenance or refinishing, can't split, warp, rot, crack, splinter or stick!
Interchangeable instrument mount (3½" 8 Thd.) Fits all standard instruments. (Other sizes available.)
Height closed 36"
Legs extended 58"
Weight 8½ lbs.
Construction: Aluminum castings with Aluminum reversible tubular legs, fittings. Finish: Anodized in high-visibility colors, resistant to all weather.
ORDER NOW FROM
SAFE-LOCK Inc.
870 West 25th St.
Hialeah, Florida

# INDUSTRIAL *water...* a job for the RANNEY METHOD



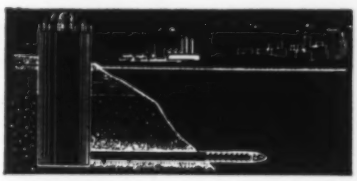
**Conventional Collector.** Proven by industries the world over, the collector that yields more naturally filtered water, with less equipment, less personnel, and fewer pumps than any other conventional collector.



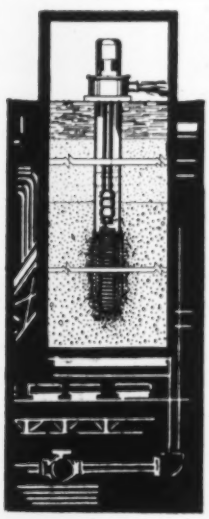
**Infiltration Gallery.** The gallery, engineered by Ranney, provides industry a low cost water supply. The gallery provides large quantities of clear non-turbid water in a revolutionary yet economical way, and it requires no maintenance.

**A Few Industries Now Using the Ranney Method**

Granite City Steel Co.
U. S. Steel Corp.
Wheeling Steel Corp.
Shell Oil Co.
The Texas Co.
American Cyanamid Co.
Eli Lilly and Co.
Allied Chemical & Dye Corp.
Monsanto Chemical Co.
Mead Corp.
MacMillan & Bloedel Ltd.
E.I. DuPont de Nemours & Co.
Olin Mathieson Chemical Corp.
Timken Roller Bearing Co.



**Ranney Intake.** The Ranney Intake, already has proven that plants and factories can obtain surface water both efficiently and economically. The Ranney Intake can usually fit into the design of your engineering department or consultant.



**Ranney Vertube.** Small industry and low volume users can now have a natural gravel vertical water well at low cost. Engineered with the same Ranney precision that has made their method a *must* for industry.

RANNEY METHOD

CI 1

**Ranney Method Water Supplies, Inc.**
841 Alton Ave. Columbus 19, Ohio
*Associated With*
Ranney Method Western Corporation
Ranney Method International, Inc.

## SAW CONCRETE & ASPHALT *FASTER* WITH THE *ALL-NEW*

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"SAILS RIGHT THRU"

## SELF-PROPELLED 36 H.P. CONCRETE SAW

***Over 36 Outstanding Features Found on No Other Concrete Saw!***

Here is Engineering Leadership by Men Who Know the Concrete Sawing Industry

Other models from 1½ H.P. Gasoline or Electric Priced from **$395**

**BEST BLADES For *Every* Saw *Any* Job!**

Choose from the world's largest selection of Premium Quality Diamond Blades for the Fastest Cutting at the Lowest Cost on any job. Let your Clipper Factory Trained Representative help you select the right Saw and Blades for your job!

**Call him Collect Now!**

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**Genuine Clipper Products Sold Direct—Immediate Shipment From Factory Branches Coast To Coast**

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- ☐ Send Information on Your 36 H. P. CONCRETE SAW
- ☐ Send Information on ALL Models Concrete Saws
- ☐ Send Information on Clipper Premium Quality DIAMOND and GREEN-CON Abrasive Blades
- ☐ Send My Clipper Factory Trained Representative to see me.

NAME _____

ADDRESS _____

CITY _____

STATE _____

### 63 DIESEL CRAWLER TRACTOR

**Allis-Chalmers Mfg. Co.**—A new 14-page catalog (MS 1289) pointing up features of the HD-16 diesel crawler tractor is now available. Illustrations and text matter highlight features of the tractor. A gate fold permits a large cutaway view of both gear transmission and torque converter models. A 2-page spread tells of matched equipment available for this tractor. Specifications are also included.

### 64 DIGITAL COMPUTER

**Bendix Aviation Corp., Bendix Computer Div.**—A new, illustrated bulletin on the G-15 general purpose digital computer is now available. Featured is a full description of the simplified programming of this low-cost machine, which places it among the easiest computers to use. Engineers can be taught coding techniques within 2 to 4 hours. Specifications, accessory equipment and applications are also described.

### 65 DIRECT READING LEVEL ROD

**Lenker Mfg. Co.**—This brochure describes and illustrates the accurate and rapid method of reading elevations on the rod direct. When the graduations, which are numbered downward on the movable steel band, are set to the elevation of the bench mark, all readings are elevations.

### 66 DRAFTING EQUIPMENT

**Eugene Dietzgen Company**—Some of the products described in this 208-page illustrated catalog are: drawing boards, moisture proof tracing cloth, graph sheets, triangular scales, slide rules, drafting tables and sectional filing cases. A price list is included.

PLEASE PRINT
NAME CLEARLY

### 67 DRAFTING PAPER

**Clearprint Paper Co.**—Some of the features of Clearprint fade-out paper include easiness on the eyes, erasing without ghosting, and faster sharper reproductions.

### 68 DRAFTING PENCIL

**J. S. Staedtler, Inc.**—The leaflet "Won't Smear on Mylar!" gives information on Mars Duralar, the new drafting pencil especially developed for work on the new matte-surface Mylar tracing films. It will not smear, keeps its point, erases cleanly, reproduces perfectly. Drawings can be cleaned with soap and water, and microfilm without loss of detail. Duralar is available in 5 special new degrees of hardness (K1 to K5) in pencils, leads, and leadholders.

### 69 DRAIN GRATES

**Irving Subway Grating Co., Inc.**—A four-page, two-color folder illustrating the use of open mesh steel flooring as drain grates is available. The folder contains photographic illustrations and shows typical uses of drain grates. There are engineering drawings of the various types and complete technical data to facilitate estimates and specifications.

### 70 DRAWING INSTRUMENTS

**Fennel Instrument Corp. of America**—This firm offers a line of drawing instruments for architects and engineers. Packaged in colorful simulated leather cases, these instruments are made by Maho, one of the finest companies in West Germany. Literature is available describing the line which is complete from flat and square types for the professional down to the inexpensive school set.

### 71 DREDGING EQUIPMENT

**Posey Iron Works, Inc.**—This catalog contains photographs of drag heads, combination wye branch and gate valve, fabricated spuds, pontoon and shore pipe, pressed steel plate ball joints with abrasion resisting steel plate liners, and hydraulic dredge hull. The company offers a complete selection of pipe and other dredge fittings to meet every dredging need. All units that are subject to abrasion are fabricated from high carbon—high manganese special dredge pipe steel or abrasion resisting steel.

### 72 EARTH TAMPER

**Jay Co.**—This catalog contains a description of the Earth Tamper and "at work" photographs. Traveling 15 to 45 ft per minute, the self-propelled tamper delivers more than twenty-two hundred 2000-lb impacts per minute, applying more pressure per square inch than a 10-ton roller, making smooth, fast and efficient work of the toughest tamping jobs.

### 73 ELECTRONIC COMPUTING SERVICE

**Statistical Tabulating Corp.**—Computer service bulletin describes a special low-cost service offering engineers time and money savings on design and development calculations through the electronic digital computer. Literature also covers the company's library of "packaged" programs available to clients without cost.

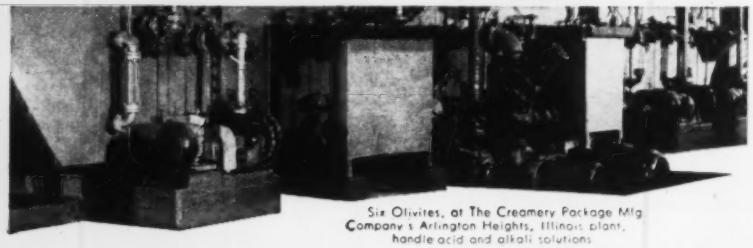
### 74 ELEVATED TANKS

**Pittsburgh-Des Moines Steel Co.**—Details of the several different types of elevated steel tanks, including capacity, ranges, tank dimensions, and other factors to be considered in the selection of storage tanks. Also available, 4 pages of pictures and discussion about flat bottom water storage.

RETURN THE COUPON
TODAY FOR IMMEDIATE
RESULTS!

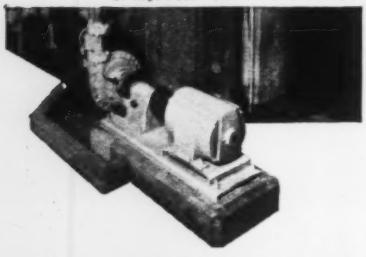

FROM DORR-OLIVER

**for tough acid and trade waste pumping problems**

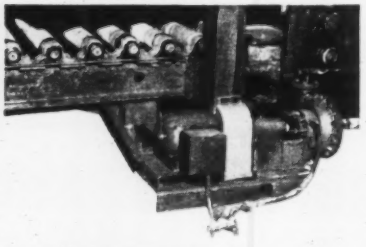


Six Olivites, at The Creamery Package Mfg Company's Arlington Heights, Illinois plant, handle acid and alkali solutions.

Hydrofluosilicic acid transfer service at Chicago's South District Filtration Plant.



Handling pickle liquor on scrubbing and drying line at Gary Sheet and Tin Mill, this Olivite has given excellent service for over three years.



**the HYPALON LINED OLIVITE PUMP**

The OLIVITE acid handling pump . . . a product of more than 30 years of specialized pump development, provides maximum protection against corrosion and leakage as well as the ability to withstand a considerable range of temperatures.

Now available exclusively with casing, cover and impeller protected by a heavy covering of E.I. duPont de Nemours & Company's new elastomer "Hypalon," the OLIVITE pump is virtually hand-tailored for applications involving either highly acidic or alkaline material.

Currently available in 1¼", 2" and 4" sizes. Complete information in the new Dorr-Oliver Centrifugal Pump Bulletin, just off the press.

Write: Dorr-Oliver Incorporated, Stamford, Connecticut.

DORR-OLIVER INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD CONNECTICUT U.S.A.

OLIVITE-Reg. T.M. U. S. Pat. Off. Hypalon-Reg. T.M. E.I. duPont de Nemours & Co.

### 75 ELEVATED WATER TANKS

**Graver Tank & Mfg. Co., Inc.**—Suitable for framing are the handsome single sheet reprints of the company's full-color ads on behalf of elevated water tanks. These inserts have useful tables on the back listing the standard sizes of the various types of tanks the company builds for water—elevated water tanks, pump suction tanks standpipes and reservoirs.

### 76 ENGINES & POWER UNITS

**International Harvester Co.**—Some of the power features listed in this pamphlet for the V-8 carbureted model are: downdraft carburetion for maximum power with minimum fuel consumption; fully machined combustion chambers for equal high compression in all cylinders. The 4- and 6-cylinder diesels have dependable all-weather starting; long-life, full-pressure lubrication; and precision fuel injection system. Each engine is pictured and its specifications given.

### 77 ENSLAG COLMIX

**Vulcan Materials Co.**—A bituminous paving mixture that may be laid cold. Specifications and technical data included in an 8-page booklet. Of particular interest are results of tests undertaken by various state and government agencies, which prove the superior skid-resistant characteristics of blast furnace slag, the aggregate contained in Enslag Colmix. Pictures show actual application. Charts and text outline the varied uses for this versatile paving material.

Turn to page 144 and order your literature.

### 78 EXPANSION PLATES & BUSHINGS

**Lubrite Div., Merriman Bros., Inc.**—Manual No. 55 contains complete information, technical data, and specifications about self-lubricating expansion plates and bushings for bridges, buildings, refinery equipment and chemical processing equipment applications.

### 79 EXPOSED CONCRETE AGGREGATE

**Sika Chemical Corp.**—This 4-page brochure describes two ways of obtaining exposed concrete aggregate during construction. This exposed aggregate can serve as a bonding surface at construction joints or have a decorative architectural effect. On horizontal surfaces, Rugasol-C, Retardant Concrete Coating is applied directly on the freshly placed concrete. On vertical surfaces, or precast panels, Rugasol-F, Retardant Form Coating, is applied on the forms before or after erection.

### 80 FABRICATED PIPE & PILING STEEL

**Posey Iron Works, Inc.**—This 15-page catalog contains in-shop and field installation photographs, which are typical of the wide variety of jobs fabricated by the company. A few of the illustrations included are: car of pipe leaving plant, driving 30-in. OD Piles for bridge piers, special steel fabrication for oil refinery, and special fitting of stainless steel.

### 81 FABRICATED STEEL PRODUCTS

**United Steel Fabricators, Inc.**—Complete details, specifications and engineering data are available on highway guard rails, bridge flooring, corrugated metal pipe, metal buildings, and steel forms for concrete bridge decks.

### 82 FASTITE JOINT PIPE

**American Cast Iron Pipe**—This illustrated 12-page brochure describes the advantages of the double-sealing single gasket type joint. The booklet contains instructions for assembly, weights and dimensions, and typical installations of the pipe for water, sewage and other liquid service.

### 83 FIBRE FORMS

**Sonoco Products Co.**—Uses of Sonotube, fibre forms, are illustrated in a brochure. These fibre forms provide an economical method of forming round, obround, half-round and quarter-round columns. Also encasement of steel and wooden piles, existing columns and utility risers. Available in several different types, the newest which provides a form surface requiring little or no rubbing of the finished column. Technical data also available.

### 84 FIBRE TUBES

**Sonoco Products Co.**—Sonovoid, fibre tubes, were specifically developed to form voids in bridge decks; wall, floor, roof and lift slabs and in concrete piles. Uses illustrated in a brochure. Sonovoid, fibre tubes, are used in precast or cast-in-place units of conventional or pretensioned construction. Tie down and spacer method shown along with design data for 8-in. and 12-in. slabs. Other technical data available.

### 85 FIELD EQUIPMENT

**Warren-Knight**—Part 1 of two brochures concerning Engineering Equipment & Supplies, has been published. Entitled "Field Equipment" this booklet includes write-ups and photographs on transits and levels, compasses, measuring tapes, spring joint rules and survey markers. Paragraphs concerning instrument care and repair are included in this 24-page booklet.

In filling out the coupon, please print clearly and be sure that you furnish a complete address.


CONCRETE TESTERS

*The World's Finest Low-Cost Precision Testers*

For
CYLINDERS
CUBES
BLOCKS
BEAMS
PIPE

IF IT'S A CONCRETE TESTER YOU NEED-GET IN TOUCH WITH

**FORNEY'S, Inc.**
TESTER DIVISION
P. O. BOX 310 · NEW CASTLE, PA.



In the field of
HYDRAULIC DREDGING

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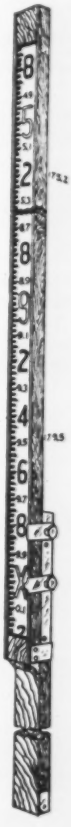
a leading name for over 50 years

Gahagan Dredging Corporation, 90 Broad Street, New York 4, N.Y. Write, wire, or phone Whitehall 3-2358. Cable "Walgahagan".





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•

**LENKER**
**DIRECT READING**
**LEVEL ROD**

•

Every Rod Reading an Elevation

•

No Computations

•

Awarded Medal of Merit for Utility by Franklin Institute of Philadelphia

*Write for Circular*

**LENKER MFG. CO.**
599 CHESTNUT STREET
SUNBURY, PA.

### 86 FILM OFFERED

**Layne & Bowler, Inc.**—Entitled "Deep Waters", this full color, sound 16-mm motion picture film on ground water development portrays how water reaches the underground formations with animated sequences of underground processes which could not be photographed; and how water is located and the processes necessary for its production in ample quantities. The picture runs 22 minutes and is available to interested groups for showing without cost.

Please give your complete address.

### 87 FILTER MEDIA

**Anthracite Equipment Corp.**—A bulletin on "Anthrafilt" tells the reasons why selected, graded crushed anthracite is superior to sand as a filtering material. Information about a free technical advisory service is included.

### 88 FLIGHT SIMULATOR

**Bendix Aviation Corp., Bendix Computer Div.**—A description of the 3-Dimensional Flight Simulator and its applications are explained in a 24-page illustrated bulletin. The expense of testing missiles, aircraft navigational systems and associated components can be materially reduced through the use of the Simulator which is comprised of a 3-axis flight table and a complementing analog computer. Control with this system reduces or eliminates the need for expensive trial flights in "debugging" airborne systems.

### 89 FLOOR ARMOR

**Irving Subway Grating Co., Inc.**—A 24-page color catalog on Gridsteel floor armor. Gridsteel is made of steel bars on edge, bent and joined together in a continuous hexagonal mesh pattern. Floors armored with Gridsteel last indefinitely. Gridsteel prevents ruts or potholes from forming, gives an even, tractional floor surface at all times. Catalog illustrates uses, advantages, and shows how quickly and simply Gridsteel is installed.

### 90 FORMING

**Blaw-Knox Co.**—The company's important contribution to the completion of the St. Lawrence Seaway is graphically illustrated and described in a 16-page booklet (Form 2559). On this billion dollar project, new standards of steel form designs and usage were established. For Barnhart Island alone, engineers prepared over 1,000 drawings. The St. Lawrence project, eventually, received over 126 car loads of steel forms.

### 91 FOUNDATION CAISSONS & PILES

**Franki Foundation Co.**—An interesting, informative and well illustrated brochure describes in detail the Franki method of installing Displacement Caissons and Pressure Injected Footings. Caisson load test results on representative projects and reinforced concrete cap design data are noted. Various types of pile foundations installed by Franki are indicated.

### 92 FOUNDATION PIPE

**L. B. Foster Co.**—Comprehensive information of spiralweld foundation pipe piles is presented in a 24-page booklet. In addition to detailed specifications, the photo-illustrated brochure describes a number of pipe pile installations and includes typical driving logs. A special feature is a table giving complete specifications of all popular pile hammers, including new diesels.

### 93 FREE TURQUOISE DRAWING PENCIL

**Eagle Pencil Co.**—The sample will enable you to test the exceptional point strength, smoothness, durability and opacity of a lead made with 100% "Electronic" graphite. Microphotographs 7500 times actual size show the actual lead structure and the density of the line deposited.

### 94 GEAR DRIVE

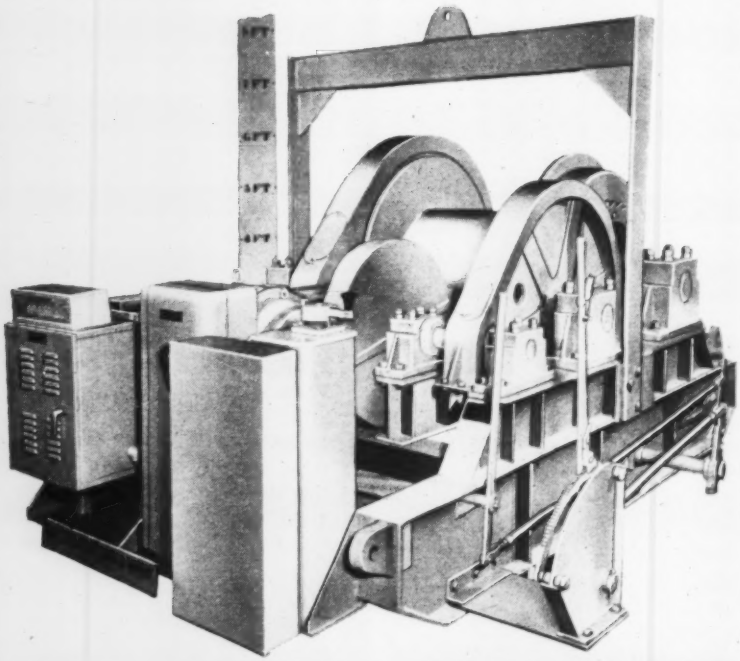
**Johnson Gear & Mfg. Co.**—Right angle gear drives for vertical shaft pumps and industrial use such as sewage disposal, water supply, fire and flood control, cooling tower installations, and barge service, are described and illustrated in catalog #29 and #30. Complete engineering details are also given.

### 95 GEARS

**The Earle Gear and Machinery Company**—A twenty-page catalog describes in general, the kinds and sizes of gears manufactured by this company. Its contents deal with spur gears, bevel gears, helical gears, worm gears, racks, non-metallic gears, sheaves, sprockets, special machinery of which gears form a part, and special gear information. Illustrated with photographs, it also shows actual Earle installations.

### 96 GILSULATE INSULATION

**American Gilsonite Co.**—Presented in this bulletin are data for 3 grades of Gilsulate. One section gives a method of determining ditchc size and the resultant size of the Gilsulate envelope for single pipes or any combinations of pipes from 1-in. to 12-in. nominal diameter. Also available is a 4-page pamphlet giving eight reasons for using Gilsulate.

# "ALL STEEL" ERECTION HOISTS *safe · reliable rugged · dependable*

**These combined qualities are all included in the hoist shown and are provided by "All Steel" construction, no clutch, single lever "Deadman" type electrical control, lifting hitch for moving, and husky tie backs for anchoring.**

The load is over 200 tons on multiple parts of line requiring a drum capacity of over 3000 ft. of 1¼" cable, the lift must be made with absolute assurance of reliability and the answer is a S-L-M "All Steel" erection hoist. Consult Superior-Lidgerwood-Mundy for your next reliable hoist.

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**Superior–Lidgerwood–Mundy Corporation**

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**NEW YORK OFFICE—7 Dey St., New York 7, N. Y.**

### 97 GRATING DATA

**Klemp Metal Grating Corp.**—A completely new 20-page manual containing safe load tables for welded grating, riveted grating, and new aluminum gratings has been published. It also contains illustrations and technical drawings of floor armors, ganister liners, bridge decking and drain grates. Fully illustrated, it is designed to be of invaluable assistance to the engineer and architect.

### 98 GRATING FLOORING AND TREADS

**Irving Subway Grating Co., Inc.**—General Grating Catalog F400 contains illustrations, descriptions and complete engineering data on full line of grating products made in steel, aluminum and other metals. Catalog shows riveted, welded and pressure-locked types for use as flooring, treads, walkways, trench covers, and so on. Irving grating is safe, durable, self-draining, ventilating, clean, fireproof, economical.

### 99 GRATINGS

**Borden Metal Products Co.**—A 16-page catalog shows the three basic types of grating construction; more than 30 dimensional drawings of subtypes; eight safeload tables covering steel and aluminum gratings, roadway grating and sidewalk slabs plus other tables on panel widths, tread widths, floor armor, etc. Also shown are the various safety treads and their nosings. Included are the steps for careful planning and checking of the job.

### 100 GUARD RAIL

**Granco Steel Products Co.**—A product manual contains 8 pages of application photographs, standard drawings, specifications, curving data installation instructions and facts on non-highway use of the Granco deep beam guard rail for highways and bridges. Corrugated from tough carbon steel to act as a continuous impact-resistant beam, its inherent characteristics and engineered features provide hi-strength visual barrier, greater safety, no pocketing, interchangeable sections and economy.

### 101 GUNITE

**Pressure Concrete Co.**—Gunite in all phases is described and illustrated in a 48-page booklet which contains complete specifications. Illustrations show Gunite repair of reservoirs, dams, filter plants, sewage disposal plants, stadiums, bridges, stacks and bunkers. The booklet also contains photographs on prestressed tank construction and other data. A leaflet illustrates pressure grouting to dams.

### 102 GYPSUM ROOF DECKS

**National Gypsum Co.**—Technical Bulletin #589 gives a description of materials and methods, plus specifications used in the construction of poured gypsum roof decks. It contains tables for selecting steel framing members, and describes a wide variety of formboards for conditions requiring insulation and acoustical treatments.

### 103 HEAVY-DUTY COLUMN

**Shlagro Steel Products Corp.**—A new "space saver" column that supports more weight in relation to the steel and concrete used and the area displaced, is described in Catalog #225. Modern and trim in appearance, it is a unique composite of hot rolled steel sections and concrete fill. In the manufacture of this column, steel plates are welded to the flanges of the beam to form a square column. The column is then filled with concrete by a special method. In making full use of steel and concrete, the company has developed a column with approximately equal strength on both axis.

### 104 HIGH STRENGTH STEEL DESIGN MANUAL

**United States Steel**—The first complete text on how to design high strength low alloy steels. Concise, well-written, it covers unit stresses, beams and columns, plates, riveting and designing to thwart corrosion. Probably the only basic text extending design fundamentals to the higher strength levels of high strength steels.

### 105 HIGHWAY CONSTRUCTION

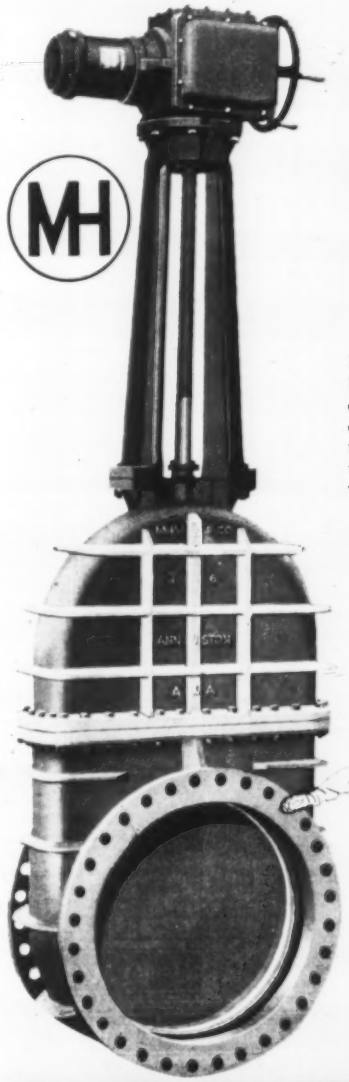
**American Steel & Wire Div., United States Steel Corp.**—Here, under one cover, is a description of the company's products for use in highways and streets. They include: Welded Wire Fabric, Multisafety Cable Highway Guard, Beam Guard, steel and wire products for Prestressed Concrete, steel and wire products for Reinforced Concrete Pipe, American Welded Wire Fabric for tunnel and bridge construction, and for bituminous concrete road repairs.

### 106 HORIZONTAL SHORING

**Spanall of the Americas, Inc.**—Some of the features of Spanall Horizontal Shoring which this 8-page, illustrated brochure gives are: the sections assemble fast and easy; it is versatile, as it adjusts to a wide range of span lengths, eliminating need for costly intermediate vertical shoring; and it automatically sets correct camber. Also available is a sheet on S-L Spanall, the newest of all-metal adjustable supports used in suspended formwork.

### 107 HOT WEATHER CONCRETING

**Sika Chemical Corp.**—Complete information on controlling the set of concrete during hot weather is available. Test data, specifications and technical information on Plastiment Retarding Densifier are included.

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FOR BIG VALVES

Remote operation and control of valves by electric motors is not only a great convenience but frequently increases efficiency and reduces operating costs. Electric motor operation is recommended for valves which are frequently operated or valves which are located in remote or inaccessible or hazardous places. (If preferred, M & H cylinder operated valves may be used for similar service.)

All types of M & H Gate Valves are available with electric motors installed on the operating mechanism. They are standard M & H valve design and construction, i. e., iron body, bronze mounted, double disc, parallel seat, or solid wedge as desired. Illustrated at the left is a low pressure 36-inch motor-operated M & H Valve. For detailed information, *write or telephone...*

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

SUBSIDIARY OF WALWORTH

### 108 HOW TO CORE DRILL

**Acker Drill Co., Inc.**—"Basic Procedures of Diamond and Shot Core Drilling" shows with over 80 illustrations and drawings the fundamentals of core drilling practice. Pipe driving, core recovery, core logging and storage are all covered in this pocket size book for the beginning driller. The price is $1.00.

N. B. There is a charge for this book. Make checks payable to Acker Drill Co., Inc.

### 109 HYDRAULIC TURBINES

**The James Leffel & Co.**—Details on the turbines which drive both power generation and pumping units at the United States Bureau of Reclamation, Chandler Power and Pumping Plant, are given in a 12-page Bulletin 1098-E. Descriptive literature on other recent turbine installations will be inclosed.

### 110 HYDRO EQUIPMENT

**Pacific Coast Engineering Co.**—Information is available on the company's services to the power industry. A single source for all hydro hardware including cranes, hoists, gates, trash rakes, valves, draft tubes, conduits, penstocks and fittings, it can reduce initial costs because all parts can be coordinated in both design and fabrication, and it can maximize the operating efficiency of each unit.

### 111 HYDRO EQUIPMENT & CRANES

**Yuba Mfg. Div., Yuba Consolidated Industries, Inc.**—Information is available describing the company's hydroelectric equipment and services and specialized lifting equipment such as bridge cranes, derricks and hoists. The company is able to handle the complete job from custom design through machining, fabrication, testing and erection.

### 112 HYDROGRAPHIC EQUIPMENT

**Leupold & Stevens Instruments, Inc.**—Bulletin 18 describes the Stevens Surface Detector, a servo-control mechanism which replaces the usual float for operation of water level recorders or transmitters. The unit is dry cell battery powered and will operate 6 months with one set batteries. Although it requires only 3-in. i.d. pipe for vertical operation, it assures accuracy of water level registration to 0.01 ft.

### 113 INSTRUMENTS

**Filotecnica Salmoiraghi**—Presents an attractive general catalog, complete line of revised instruction manuals and descriptive pamphlets covering each of the F/S instruments advertised in "Civil Engineering"; Optical Theodolites; Conventional and Self-Leveling Levels; Planimeters, etc.

### 114 INSULATING MATERIAL

**Pittsburgh Corning Corp.**—According to this 11-page, fully illustrated brochure, Foamglas, an all-glass thermal insulating material composed of millions of hermetically sealed cells, combines the two most desired characteristics of an "ideal" curtain wall panel insulation—rigidity and exceptional compressive strength. Some of the features of this cellular glass insulation are: constant insulating value, waterproof, lightweight and strong, rigid, and dimensionally stable.

### 115 INTERCOM 1000

**Bendix Aviation Corp., Bendix Computer Div.**—A four-page bulletin describing the unusual features of a new programming method has been published. Known as Intercom 1000, this system has been designed for use with the G-15 general purpose digital computer and is a major simplification in the process of writing instructions to a computer. The system can be learned in four hours or less, with no previous computer experience.

### 116 JETTING PUMPS

**Griffin Wellpoint Corporation**—A booklet illustrates jetting pumps for pile and caisson jetting, oil pipe line testing, water supply and fire protection. The illustrations show unusual set-ups for high-pressure jetting, including parallel and series pumping arrangements.

### 117 JOINT SEALER AND WATERSTOP

**Sika Chemical Corp.**—A brochure describes the four new consistencies of Igas Joint Sealer. The stiffer consistencies are used for water reservoirs, swimming pools, tunnels and deep basements. Lighter consistencies are used where there is no actual water pressure such as joints in metal building panels. Specifications and architectural details are included.

### 118 KOMPACTOR

**Buffalo-Springfield Roller Company**—Some of the profitable features listed in this illustrated booklet on the Model K-45 Kompactor are: torque proportioning type differential, fast action instruments and controls, rugged front axle assembly and massive, all-welded frame.

### 119 LIFTING INSERTS PRECAST CONCRETE

**Richmond Screw Anchor Co., Inc.**—A line of lifting inserts for precast piles, beams, slabs, columns, tilt-up walls and prestressed girders is described in this sixteen-page booklet. Complete data, working loads and ultimate strengths are given for each item in concrete of different strengths. Summaries included give pertinent information and results of all tests. Photographs and line drawings show details of application.

### 120 LIGHTING STANDARDS

**Kerrigan Iron Works, Inc.**—A new multi-page loose-leaf catalog containing engineering data on steel and aluminum street lighting standards, mast arms and brackets has been published. They are continuous tapered and octagon shaped for greater strength. The brochure contains comparison tables on strength of octagon shape over round and fluted shapes.

### 121 LIGHTWEIGHT ACKER PACKSACK CORE DRILL

**Acker Drill Co., Inc.**—will send to interested readers a copy of their Bulletin 1000 which describes their lightweight Acker Packsack Diamond Core Drill. The drill can be powered by either an air motor or gasoline engine. The gasoline engine drill weighs only 32-lb and will drill a $\frac{7}{8}$-in. core to depths of 100-ft. It is ideal for preliminary sub-surface work.

### 122 LIGHTWEIGHT AGGREGATE-CONCRETE

**The Master Builders Co.**—The 20-page Reporter No. 14 illustrates the wide use of lightweight aggregate concrete in modern construction. Photographs and job stories present a clear picture of the wide variety of uses for this relatively new and versatile building material. Job stories cite the role played by Pozzolith in providing adequate workability for proper placement while economically maintaining sufficient strength to meet structural requirements.

### 123 LIGHTWEIGHT PIPE & FITTINGS

**Naylor Pipe Co.**—New Bulletin #507 illustrates and describes spiralweld pipe for construction uses. Push-pull ventilation, high and low pressure air and water lines, dredging pipe, etc. in diameters from 4 to 30 in. It includes standard fittings, welded flanges, one-piece Wedge-lock couplings, and connections for all pipe line requirements.

### 124 LIGHTWEIGHT SHEET PILING

**L. B. Foster Co.**—This brochure lists specifications and uses of lightweight steel sheet pilings for protecting light-load excavations. Because of its box-type corrugated design, the interlock of lightweight sheeting cannot jam. It locks rigidly when installed, but comes apart easily. The literature shows how the piling, which can be rented or bought, can be reused repeatedly. Typical applications are shore protection, sump pits, sewer trenches, bulkheads, cofferdams, and building excavations.


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# CATALOG DIGESTS

### 125 LIMI-TORQUE CONTROL

**Philadelphia Gear Works**—28-page catalog L-550, gives background information on this automatic, power activated device for controlling all types of valves and sluice gates. It describes the available types and lists specific applications. Installations are shown in power plants, refineries, and in various industries.

### 126 LINING IRRIGATION CANALS

**Portland Cement Association**—Some of the topics contained in this 34-page illustrated booklet are: general design considerations; shotcrete linings; soil-cement linings; economics of canal lining; and other uses of concrete in irrigation. A bibliography is included. Single copies distributed free only in the U. S. and Canada.

### 127 LONGSPAN JOISTS

**Haven-Busch Co.**—A 32-page catalog describing the longspan series joists SJI-AISC and includes Top Chord Extension graphs, maximum moment table, load-carrying tables, panel dimensions, and other pertinent design data.

### 128 MASONRY CEMENT

**Lone Star Cement Corporation**—A 16-page, illustrated booklet outlines the advantages of Lone Star masonry cement in simplifying the problem of obtaining uniformly high-quality mortar, as well as the economy of one rigidly standardized, ready-to-use cementing material instead of two with no lime or Portland cement to add, and no soaking or slaking. It provides timely information on soundness, low absorption, high water repellency and other factors contributing to durable, weather-resistant performance. It contains easily-read graphs showing effect of mix proportions on water retention, strength and absorption, effect of mixing time on water retention, along with convenient reference tables for estimating quantities.

Turn to page 144 and order your literature.

### 129 MEASURING FLUMES

**Thompson Pipe & Steel Co.**—Four pages of tables on Free-Flow discharge for Parshall Measuring Flumes up to 20-ft throat width are included in the catalog describing this all-steel product which provides accurate measurement of water and fluids in open channels and ditches for irrigation systems, water works, sewage and industrial plants. They are also made of stainless steel and aluminum.

### 130 MECHANICAL DRAWING EQUIPMENT

**Eberhard Faber Pencil Co.**—A full color descriptive catalog sheet illustrating Microtomic mechanical drawing pencils and leads; wood-cased drawing pencils and engineering erasers has been made available. Three different types of erasers are described—No. 521, Race Kleen plastic eraser; No. 101, Pink Pearl; and No. 6002, Rubkleen.

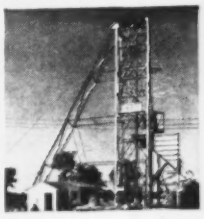
### 131 METERS, FEEDERS, CONTROLS

**B-I-F Industries, Inc.**—This catalog provides a general coverage of equipment made by this company and its divisions. Photos of equipment as well as installation photos and brief descriptions of many products including flow, level, and pressure or temperature meters, liquid and dry material blenders, diatomaceous earth filters, liquid and dry feeders, control equipment and apparatus, and equipment accessories are included.

### 132 MINING & TRANSMISSION MACHINERY

**The Jeffrey Mfg. Co.**—Besides mining and transmission machinery, this 47-page booklet illustrates chains, sprocket wheels, elevating machinery, mechanical feeders, magnetic separators, foundry equipment, bin valves, crushers, and grinders and hashers.

**MAYO ALL-STEEL**
**SINKING FRAMES and HEAD FRAMES**



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- Shields
- Air Locks
- Locomotives
- Mine Cars
- Grouters

**MAYO**
**TUNNEL AND MINE EQUIPMENT**
**LANCASTER, PENNSYLVANIA**


### 133 MIXED FLOW VOLUTE PUMPS

**C. H. Wheeler Mfg. Co., Economy Pump Div.**—Low- and high-head mixed flow volute pumps for sewage disposal, drainage, flood control, irrigation, raw water pumping, or for any relatively clear liquids are described in a 6-page two-color catalog. Design and construction details for horizontal and vertical pumps are presented.

### 134 MODERN COMPACTION METHODS

**Bros, Inc.**—To help bring some of the current problems into focus, this 51-page manual presents some recently published articles on specific compaction problems and equipment applications. Also, a glossary of some of the most commonly used compaction terms and their meanings has been included for possible reference by the reader.

### 135 MOTOR GRADER

**Allis-Chalmers Co.**—Working advantages provided by the Model Forty Five Motor Grader are covered in a 16-page, 2-color catalog. Photographs, sketches and other instructive illustrations aid readers to visualize details of the motor scraper's mechanical features and components. On-the-job photographs further assist in telling the performance, operating, comfort and service simplicity of the Forty Five. The catalog also tells about attachments and accessories that add to the versatility of the unit, and includes its specifications.

### 136 MOTOR GRADER

**Galion Iron Works & Mfg. Co.**—An informative 4-page bulletin on the Model 160 Motor Grader has been issued. The heavy-duty, constant-mesh, six-speed transmission of this big 160-hp grader, as well as other operating and construction features, are fully described and illustrated. Complete specifications are included.


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No need to let cost problems get out of hand . . . you'll find easy solutions in this practical guide book, CONSTRUCTION COST CONTROL. Here are the answers to the complete cycle of estimating, accounting, distributing and analyzing of all operational and overhead costs. The authors are practical construction men thoroughly experienced and ready to help you with illustrations, charts, and specimen accounting forms. This 97 page book measures eight-and-a-half by eleven inches and is sturdily bound. Don't wait any longer — mail the coupon, today!

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### 137 MUNICIPAL & INDUSTRIAL SANITATION

**Dorr-Oliver, Inc.**—A 4-page, two-color bulletin entitled, "Seven Developments for Municipal & Industrial Sanitation", assembles for review in a single brochure data on seven major equipment designs and process developments introduced in the past three years. It includes photographs, line and wash drawings and descriptive sketches of each development.

### 138 MUNICIPAL WATER TREATMENT

**General Filter Co.**—Directed at the small municipality, this paper, written by V. M. Roach, reviews the problems of municipal water supply. It is pointed out that the design of a water treatment plant for any of the treatment problems must be approached with the idea of providing the necessary facilities at a price the purchaser can afford to pay. In the case of the small towns, the problem of finances places design limitations on the engineer and the equipment manufacture, and calls for careful study of treatment methods in order to eliminate unnecessary expenditures.

### 139 NATURAL CEMENT

**The Wait Associates, Inc.**—Included in this 48-page booklet is a description of Rosendale Natural Cement, its functions and beneficial effects when used in a blend with portland cement; the general and diversified uses of the blended cement in concrete and mortar; its outstanding record of successful performance, and its long-time qualities of durability in all classes of concrete construction under varying conditions of exposure and usage.

Please give your complete address.

### 140 NEW T-16 OPTICAL TRANSIT

**Wild Heerbrugg Instruments, Inc.**—Many new design concepts are embodied in the T-16 Optical Transit, now available. The instrument is reportedly designed for ease and speed of operation. Circles are read at a glance to 1-min directly and to 20-sec by interpolation. A built-in repeating clamp is used for setting on zero and eliminates lower plate motions. A new optical plummet giving an upright image has also been incorporated in the T-16.

### 141 NON-CLOG PUMPS

**Aurora Pump Div., The New York Air Brake Co.**—Bulletin 121A describes vertical, horizontal and close-coupled non-clog pumps for public utility and industrial applications. It includes features, specifications, close section drawings and typical installations.

### 142 ONE-WIRE SYSTEM

**Intercontinental Equipment Co., Inc.**—A brochure is available on the P.S.C. One-Wire System of Prestressing, which is the latest newcomer to the field of prestressing techniques. This post-tensioning system is designed primarily for smaller prestressing cable forces than the Freyssinet method. The system is based on either single or grouped high tensile steel wires which are tensioned and anchored individually.

### 143 OPEN STEEL BRIDGE FLOORING

**Kerrigan Iron Works, Inc.**—A catalog on Greulich 4-way Grid, 5-in. depth. It contains illustrations, full engineering data including properties and load tables. The pamphlet explains the ease of filling half depth with concrete where needed, economical, speedy field erection, and why 20% fewer field welds are needed. Grid fabricated in panels 7-ft 3-in. wide with lengths up to 42-ft.

### 144 PAVING HANDBOOK

**American Bitumuls & Asphalt Co.**—The latest edition of the Bitumuls Paving Handbook covers a wealth of practical data on paving methods and materials. These include road and airport paving specifications and construction details, complete tabular data on asphaltic binder applications and aggregate requirements, with condensed Asphalt Institute specifications. Also, there is data on Laykold compounded asphalts for flooring, tennis courts, and protective coatings.

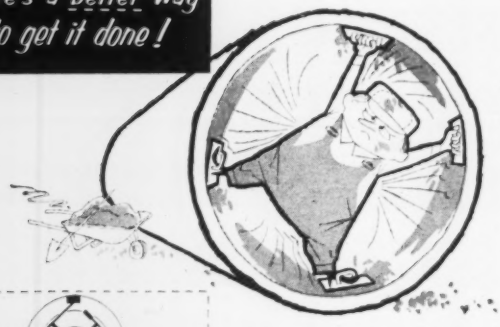
### 145 PAVING PRODUCTS CATALOG

**W. R. Meadows, Inc.**—A catalog on Sealtight Paving Products . . . covering asphalt expansion joints, corkfill expansion joints, fibre expansion joints, center strip, dummy joints, concrete curing compounds, subgrade paper, base plate, rubber asphalt joint seal, sewer joint compounds and road marking paints is offered. The catalog not only contains all of the general information on each product, but also a Standard Specifications section that truly explains what specifications each product meets.

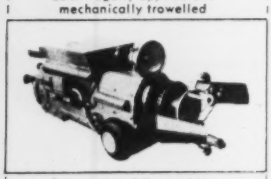
### 146 PENTAGONAL PRISM

**Kern Instruments, Inc.**—A 4-page color brochure on pentagonal prisms is available. It goes into detailed description of what a pentagonal prism is, who uses it and for what purpose. It also shows, with the help of diagrams and detailed description, how it is used to check and set up right angles, to establish a point on line, to measure angles other than 90-deg and all other major applications.


*there's a better way to get it done!*



Centrifugally applied and mechanically trowelled



Compact, mobile machine moves through the line

Centriline Process applies smooth, continuous leak-proof lining to inside of 16" to 144" pipe lines "in place." Applicable to fresh or salt water, oil, gas or industrial waste lines. Eliminates interior corrosion and leakage. Restores full flow coefficients.

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IN DRAFTING ROOMS
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THE WORLD IS
TOWARD
THE WORLD'S FINEST
IMPERIAL,
TRACING CLOTH

## CATALOG DIGESTS

### 147 PILE DRIVING

**C. L. Guild Construction Co., Inc.**—An eight-page brochure entitled "Pile Driving" includes a fairly comprehensive brief on piles and pile driving. This literature also describes in great detail the Cobi Cast-in-Place Concrete Pile, gives specifications and the method of installation. The brochure is amply illustrated with action photographs and various completed structures which rest on Cobi piles. Included also are detailed examples of recent load tests made on Cobi Cast-in-Place Concrete Piles.

### 148 PILES

**Raymond Concrete Pile Company**—Standard and step-tapered piles are described in Catalog S-58 which also includes information on the scope of Raymond's activities covering every recognized type of pile foundation. Domestic operations include harbor and waterfront construction, and cement-mortar lining of pipelines in place. Raymond's services abroad also include all types of general construction.

### 149 PILES

**The Union Metal Mfg. Co.**—Catalog No. 81 on Monotube piles, in addition to general descriptive information, contains engineering data covering physical properties, specification suggestions and test loading; also, contractor data on concrete volumes and weights. It includes numerous photos showing a wide range of job applications throughout the country. Advantages listed: light weight, easy handling, economical field extendability, visual inspection after driving, highload carrying capacity with extra high economy per ton load supported.

### 150 PIPE COATINGS

**Vulcan Materials Co.**—Teckote, a protective coating for concrete pipe, is the subject of a 6-page brochure. The manufacturer assures "life insurance" for concrete industrial and sewage lines with the use of Teckote-100. The brochure outlines tests which have been made of the product. The text is further amplified with photographs, charts, tables and specifications.

### 151 PLASTIC DESIGN OF STEEL FRAMES

**The Lincoln Electric Co.**—Bulletin No. 1301.3 is a reprint of the American Welding Society's A. F. Davis Silver Medal Award Winning Paper of 1957, "The Plastic Behavior of Structural Members & Frames". It describes a series of tests performed at Lehigh University including flexure and buckling tests on beams, welded connections of the type found in industrial buildings, and a completed gabled portal frame.

### 152 POCKET TRANSIT

**Wm. Ainsworth & Sons, Inc.**—This booklet shows how Brunton Pocket Transit is used as a compass, transit, level, plumb, alidade and clinometer. The transit shows direction to 1-deg; level, slope or grade within 1-deg; weighs only 9-oz. Its size is $2\frac{3}{4}$-in. by 3-in. by $1\frac{1}{8}$-in.

### 153 PORTABLE GASOLINE RAMMER

**Barco Manufacturing Company**—Offers an eight-page catalog describing the Barco portable gasoline rammer for soil compaction. This tool is the only successful mechanical means of obtaining specified soil compaction in restricted areas such as in trenches and near walls and bridge abutments. It is easy to operate, safe, and will compact 20 to 30 cubic yards of fill per hour where high degree compaction is specified. Barco also offers a bulletin "Cost Data for Soil Compaction in Restricted Areas with the Barco Rammer" of interest to all earthmoving contractors.

### 154 PORTABLE PILE HAMMER

**Vulcan Iron Works, Inc.**—Some of the features of the pile hammer discussed in this pamphlet are: differential-acting; modern clean design; easiness of lubrication; economically priced; and compact for close quarters and ease of handling.

Box Canyon Dam Project for Public Utility District #1, Newport, Washington. Engineer: Harza Engineering Co. Construction Managers: Morrison-Knudsen Co.

**Vibroflotation®**

**was applied to consolidate sand fill up to 30′ in depth beneath the spillway of the Box Canyon Dam.**

Vibroflotation in action at Box Canyon Dam. A compaction of over 550 cu. yds. of sandfill was maintained during each shift under adverse working conditions.

Fine sand fill up to 30′ in depth was compacted beneath the spillway and aprons of the Box Canyon Dam. VIBROFLOTATION was selected over alternate methods after considering such factors as cost, time, and construction convenience. A minimum relative density of 70% (average of approx. 85%) was achieved. Because of the urgency of the project, 13,900 cu. yds. were compacted in 25 shifts on an around-the-clock basis.

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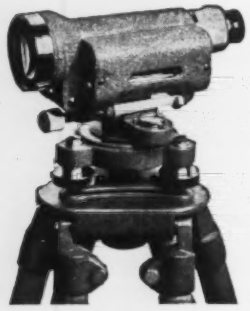
KERN'S NK3 Precise Engineers' Level. The world famous engineering tool especially designed for accurate leveling.



The NK3 offers over 100 years of Swiss Master Craftsmanship and the latest technical achievements compressed into 4 lbs. of maximum precision, operational efficiency and economy.

- Mean leveling accuracy per mile (normal conditions) ± .008 Ft.
- Coincidence bubble is viewed directly through 30X telescope, allowing constant check on bubble centering while reading rod.
- Ready for use right out of the case. Highest precision leveling with coincidence spirit level and tilting screw. Coated optics give increased brilliance and contrast in the image.

**MORE RELIABLE READING IN LESS TIME!**

*Ask for Detailed Brochure NK527-2*

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FACTORY TRAINED PERSONNEL

Kern SWISS — *The FINEST in SURVEYING EQUIPMENT*

**KERN INSTRUMENTS INC.**

120 Grand St., White Plains, N.Y.


# CATALOG DIGESTS

### 155 POWER HOUSES

**Ingalls Iron Works Co.**—A 36-page booklet illustrates numerous power houses and plants fabricated and erected by Ingalls, a major fabricator of structural steel and plate work for power houses.

### 156 PRECAST CONCRETE BRIDGE MEMBERS—AMDEK

**American-Marietta Co.**—An 8-page folder shows how Amdek prestressed, pretensioned concrete spans revolutionize bridge construction methods. It also illustrates skew beam tests, load distribution tests and tests to destruction being conducted in independent laboratories.

### 157 PRECISION INSTRUMENTS

**C. L. Berger & Sons, Inc.**—"Solar Ephemeris and Polaris Tables," 96 pages, contains complete instructions for determining azimuths from the sun and the altitude of Polaris, has been prepared by Herman J. Shea, formerly Associate Professor of Surveying, Massachusetts Institute of Technology. Directions for making astronomical observations and computing results by direct solar observation and time from same observation; meridian by solar attachment; meridian by Polaris at elongation; azimuth by Polaris at any hour angle; latitude by sun at noon, and latitude by Polaris are included. Price is $.50 per copy.

N. B. There is a charge for this book. Make checks payable to C. L. Berger & Sons, Inc.

### 158 PREMOULDED JOINTS

**Expansion Joint Institute**—This technical brochure is designed to provide engineers, architects and contractors with authoritative up-to-date information concerning the design, construction and maintenance of joints in concrete pavements. The manual contains a brief general discussion of joints and their uses in concrete pavements and slabs. Fundamental considerations concerning volume changes in concrete pavements and associated stresses are covered. The consequences of failure to provide adequate joints in concrete pavements are explained.

### 159 PRESTRESSED CONCRETE PILES

**Raymond Concrete Pile Co.**—Catalog CP-3 describes and illustrates Raymond cylinder piles of prestressed concrete. Information is given on the merits of prestressed concrete piles for foundations of bridges, waterfront and offshore structures. Shown are many examples of installations and suggested designs.

### 160 PRESTRESSED CONCRETE TANKS

**The Preload Co., Inc.**—"Preload Prestressed Concrete Tanks," Bulletin T-22, is a well illustrated, 4-page booklet describing the history of prestressed tanks, design requirements, construction, walls, and floors.

### 161 PRESTRESSED CONCRETE TENSIONING MATERIALS

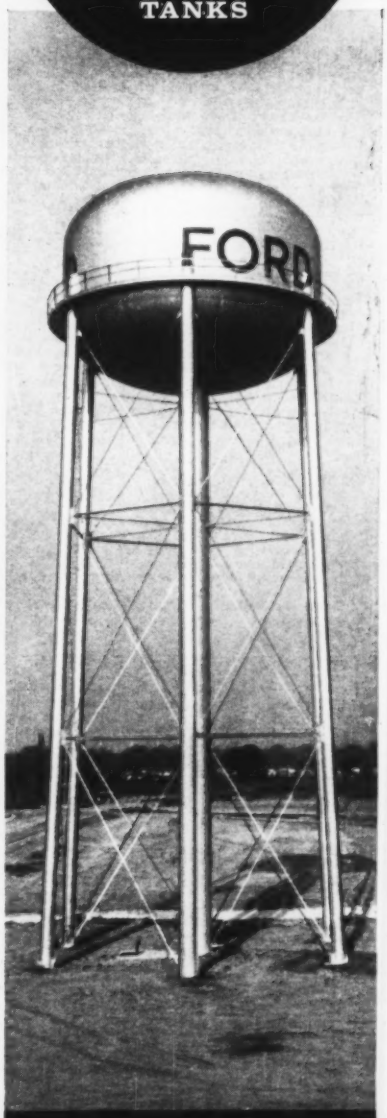
**John A. Roebling's Sons Corp.**—This brochure is a comprehensive introduction to the country's most rapidly-growing construction method. It contains 13 pages of text, photographs and drawings of various structures and pretensioned bonded prestressed concrete members and their applications. There is a full description of a prestressed casting bed and how it works and graph and technical data on tensioning strands.

### 162 PRICE LIST

**Clipper Manufacturing Co.**—The current price list includes specifications of the 2-hp Supermatic Masonry Saw and 1½-hp Select-A-Notch Masonry Saw, accessories, concrete saws, diamond, break-resistant abrasive and wet or dry abrasive blades for masonry and concrete sawing. Colorful brochures are available illustrating and outlining specifications on all masonry saws and the entire line of concrete saws with 36, 30, 18 and 9-hp gasoline engines, and 5-hp electric motors.


**INDUSTRIAL PLANTS RELY ON GRAVER®**

**ELEVATED WATER TANKS**

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Pittsburgh • Atlanta • Detroit • Chicago • Tulsa
Sand Springs, Oklahoma • Houston • New Orleans
Los Angeles • Fontana, California • San Francisco

for Elevated Water Tanks

### 163 PRESTRESS STRAND

**Leschen Wire Rope Div., H. K. Porter Co., Inc.**—A brochure is available on stress-relieved strand for prestressed concrete. Guaranteed to meet or exceed all recognized specifications including ASTM Specification A416-57T, it is a product of the company's modern methods and machines. These assure a high, uniform quality that can be obtained only as a result of using the latest and best of manufacturing and quality control techniques. The strand, for instance, is stress-relieved by heating in a high velocity gas furnace under controlled atmospheric conditions, which produces clean dry strand with excellent bonding properties from which any stresses induced by wire drawing and stranding are removed.

### 164 PUMPING STATIONS

**Zimmer & Francescon**—Completely prefabricated Underground Pumping Stations, in a range of sizes to suit all applications where extensions to sewer systems require that the flow be raised to the level of existing mains, are described in this 8-page bulletin. Engineers and Contractors for sub-divisions, shopping plazas, industrial sites and similar projects will be interested in the automatic operating features and simple installation requirements of these stations.

DID YOU MAKE YOUR CHECKS PAYABLE TO THE PROPER COMPANIES? ARE THE AMOUNTS CORRECT?

### 165 PUMPING UNITS

**Sprague & Henwood, Inc.**—A bulletin completely describes and illustrates various models of pumping units especially designed for core drilling, soil sampling and pressure grouting.

### 166 Q-AIR FLOOR CATALOG

**H. H. Robertson Co.**—This catalog contains 28 pages of information concerning the new cost-saving dimension which has been added to Q-Floor, the original cellular steel floor. This booklet covers all aspects of the high velocity dual-duct air conditioning system, including construction details, specifications, load and property tables and photos of actual erection of Q-Air Floor.

### 167 R/C DUCT FLOORS

**Concrete Reinforcing Steel Institute**—A 16-page booklet entitled "Electrical Outlets Wherever You Need Them," has been published which gives complete details on R/C Duct Floors, a development which provides 100% electrical flexibility for buildings at a new low cost. They consist of standard reinforced concrete joist floors with a network of electrical distribution ducts buried in the structural slab. With this type of construction, no special concrete "fill" is needed.

### 168 RECOMMENDED WEAR LIMITS

**Caterpillar Tractor Co.**—A list of recommended wear limits to Caterpillar crawler tractor track rollers is a feature of a new booklet. These wear limits are established as a basis for determining the most practical and economical time for having track rollers built up. Entitled "Don't Buy in the Dark," the brochure illustrates why it is important to use genuine Caterpillar replacement parts in the track components of Caterpillar-built crawler tractors.

### 169 REINFORCED CONCRETE FLOOR SYSTEMS

**Portland Cement Association**—This 20-page booklet is intended to assist the architect or engineer in making his choice of a concrete floor system. The three types of floor systems discussed are: the one-way, two-way and the flat slab. There are also many combinations and modifications of these basic types to satisfy various functional and structural requirements. Single copies distributed free only in the U. S. and Canada.

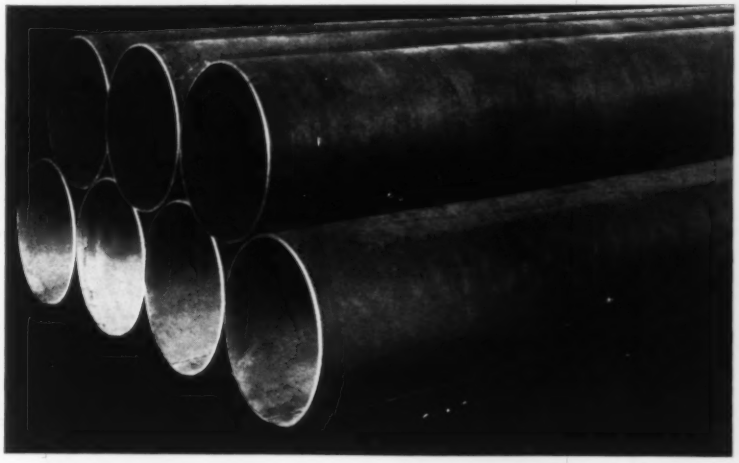
### 170 REINFORCED CONCRETE PIPE

**American-Marietta Company**—A pamphlet containing many photos showing how elliptical Hi-Hed Reinforced Concrete Pipe saves trench width in congested areas and has up to 50% greater strength than its round pipe equivalent. Includes charts on headwall details, physical characteristics and hydraulic properties and discharge graphs. Also folder on elliptical Inner Circles Pipe illustrating quick passage of pipe through pipe underground without disruption of surface traffic.

### 171 REINFORCED CONCRETE PIPE

**American-Marietta Co.**—This pamphlet covers elliptical Lo-Hed Reinforced Concrete Pipe for culverts and sewers. Specifications are given for the complete range of sizes from the equivalents of round pipe 18-in. I. D. through 144-in. I. D. Illustrations show results of pressure tests and installations of Lo-Hed pipe being made on various types of jobs.


Large O.D.
ALLOY
PIPE



fabricated to meet your requirements

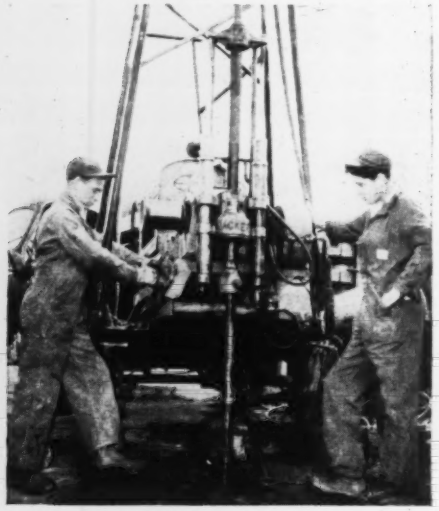
For high pressure, high temperature water lines . . . for sewage outfall lines . . . for any job requiring fabricated steel pipe of 14" O.D. or larger . . . you can depend on Posey's many years of engineering and manufacturing experience and complete production facilities. Write, wire or phone for information without obligation.

POSEY IRON WORKS, Inc.
*Steel Plate Division*
LANCASTER, PENNSYLVANIA
*New York Office: Graybar Building*

TUNNEL AND MINE EQUIPMENT • IRON AND STEEL CASTINGS • ASPHALT PLANT EQUIPMENT • BRICK MACHINERY AND MIXERS • INDUSTRIAL HEATING EQUIPMENT

# acker core drills

## *do the "underground work" wherever highways are underway!*



Contractors FROEHLING & ROBERTSON, INC., of Baltimore own the trailer mounted Acker TH Core Drill shown above. It is doing test boring for the new Cumberland Highway.

Wherever highway construction is underway, you will find Acker Equipment engaged in "underground" exploration work.

And, there's good reason!

Acker Rigs are compact, dependable and ruggedly built. Like the Acker TH Core Drill pictured, they can be furnished completely self-contained with water pump, derrick, cargo-type winch, choice of power plant and mounting on trailer, truck or jeep.

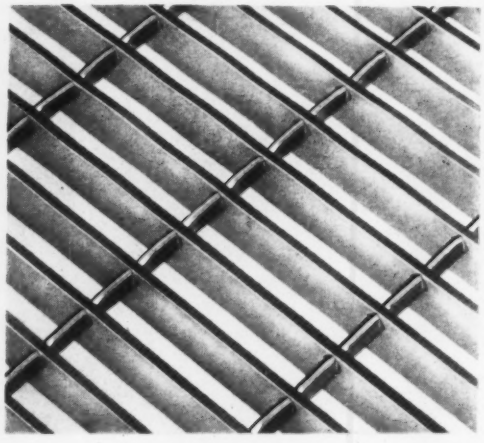
For the complete story on why Acker Core Drills are preferred by leading contractors and engineers, please write for Bulletin 30. CE

**ACKER DRILL CO., Inc.**
**P.O. Box 830 • Scranton, Pa.**

*Over 40 years of experience manufacturing a complete line of diamond and shot core drills, accessories and equipment.*

# NEW!

## Gary-Galok* SUPER ALUMINUM GRATING



**First improvement in rectangular mesh grating in over a quarter-century!**

- High strength-to-weight ratio.
- Cross bars can't turn, come loose or fall out.
- All sizes—¾" x ⅛" to 2¼" x 3/16".
- Standard mesh with main bars on 1 3/16" centers and close mesh with main bars on .915 centers with cross bars on 4" or 2" centers.
- Safe, slip-proof surface.
- Available in plain or serrated main bars.

*Patents Pending

You'll want full details about this new aluminum grating. Write for Bulletin CE-88.

ROCKWELL R STANDARD

**ROCKWELL-STANDARD CORPORATION**
**GRATING DIVISION**
4000 East Seventh Ave. • Gary, Indiana

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## CATALOG DIGESTS

### 172 REPRODUCTION FILMS

**E. I. Du Pont de Nemours & Co.**—A colorful, descriptive 6-page folder on Cronaflex engineering reproduction film is available. This folder clearly and concisely describes the properties and uses of the three Cronaflex films: direct positive; contact; and projection. Cronaflex is a new line of engineering reproduction films developed by Du Pont for the reproduction of drawings, plans and maps. All Cronaflex films are on Du Pont Cronar® polyester photographic film base.

### 173 REPRODUCTION MATERIALS

**Eastman Kodak Co.**—A new booklet outlining ways in which Kodagraph Reproduction Materials can provide short cuts and savings in reproduction departments, drafting rooms and in the field, has been published. Entitled "Short Cuts & Savings with Kodagraph Reproduction Materials," the 12-page booklet diagrams seven applications for the materials to protect original drawings, simplify print distribution, restore old and worn drawings, reproduce blueprints and direct-process prints, speed revision of drawings, permit combining of standard designs, and save drafting time with photo-drawings.

### 174 REPRODUCTION PROCESS

**Charles Bruning Company, Inc.**—Has made available an 8-page booklet explaining the principles used in the Copyflex whiteprint process. In addition to explaining the process, the booklet also describes its use in the engineering field and illustrates the complete line of Copyflex machines.

### 175 SAFETY GRATING

**The Globe Co.**—Safety Grip-Strut, an anti-skid grating in which the vertical members are joined by integral saddle to create lateral struts of great strength, is described in this 12-page booklet. General applications, installation and assembly and fastening devices are discussed. Load charts are given for both steel and aluminum grating.

### 176 SAWING MACHINE

**Concut Sales, Inc.**—A bulletin describes the improved Jointmaster Sawing Machine which is recognized as the most practical and efficient machine for large air base and highway sawing jobs. The machine is equipped with hydraulic drive for easy handling. The saw carriage is raised and lowered hydraulically and it has hydraulic torque converter cross feed. Up-cut action increases blade life. The Jointmaster is available in 12-ft and 24-ft models.

### 177 SEEPAGE & POLLUTION CONTROL

**Gulf Seal Corp.**—Long-term dependability in the eliminating of the seepage and pollution on large industrial salt water storage pits, municipal drinking water reservoirs, canals and irrigation ditches is detailed in the fourth edition of the Gulf Seal's Corp. Engineering Brochure. The experiences of cities and a wide range of industries are comprehensively described, together with a complete description and application procedure of the flexible asphalt linings.

### 178 SELF-LUBRICATING BEARINGS

**Lubrite Div., Merriman Bros., Inc.**—Manual No. 56 is a 20-page book filled with complete information, technical data, and specifications about Self-Lubricating bushings, bearings, and washers for industrial equipment, machinery and Hydro-electric type applications.

### 179 SELF-LUBRICATING BEARINGS

**Spadone-Alfa Corp.**—This literature describes Metaline Oilless Self Lubricating Bronze Bushings and Wear Plates for Industrial and Mechanical applications. Exclusive pre-molded lubricant assures, dependable service under heavy load, high temperature, submerged and corrosive conditions. They are custom made in a wide variety of bronze alloys to meet the specific duty and application.

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**Engineers**
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**Erectors**

Structural Steel
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# DESIGN HANDBOOK

*Completely revised to conform to the recently amended A. C. I. BUILDING CODE*

**REINFORCED CONCRETE DESIGNS—ALL WORKED OUT!**

No more algebraic formulas or calculations to make. Simply locate the table covering the member you are designing, apply span and load requirements, and then *read off directly* concrete dimensions and reinforcing steel data. Follows the latest codes and practices. Send check or money order for your copy, today.

*Prepared by The Committee on Engineering Practice*

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**CONCRETE REINFORCING STEEL INSTITUTE**

38 S. Dearborn St., (Div. F) Chicago 3, Illinois


## CATALOG DIGESTS

### 180 SELF-LUBRICATING EXPANSION PLATES

**Spadone-Alfa Corp.**—Literature providing complete information covering Metaline oilless self-lubricating expansion plates and bridge bushings; also, Metaline bearings for underwater installations as found in dam and hydroelectric projects. Metaline products fully meet all federal and state requirements covering this type of material. This exclusive lubricant assures long, dependable service in heavy load, high temperature, submerged and corrosive applications.

### 181 SEWAGE LIFT STATIONS

**Smith & Loveless, Inc.**—This 100-page Engineering Data Manual on factory-built sewage lift stations—pneumatic ejector and pump—contains design notes, selection charts, dimension drawings, suggested specifications, a list of installations, and installation and operating instructions. Standard lift stations range in capacity from 20 gpm to 4000 gpm.

### 182 SEWAGE REGULATORS

**Brown & Brown, Inc.**—manufacture a line of float controlled quadrant gates, in 37 sizes, to automatically control the diversion of sanitary flows from combined sewers to interceptors. Such automatic gates may be actuated either from head or tailwaters or dually from two sources. Bulletin 81A contains capacity and dimension charts.

### 183 SEWAGE TREATMENT PLANTS

**Smith & Loveless, Inc.**—A new 20-page Data Manual on "Oxigest" Factory-built Sewage Treatment Plants for housing developments, schools, motels, and factories, contains design notes, selection charts, engineering drawings and suggested specifications.

### 184 SINGLE ACTING PILE HAMMER

**Vulcan Iron Works, Inc.**—Just issued is a 20-page engineering bulletin, No. 68-P, on the selection and application of single-acting pile hammers with rated striking energy from 7260 to 30,225 ft lb. The brochure is very comprehensive and deals with many subjects such as rating of hammers, selecting size required, safe bearing load for piles, adaptability for driving, bases, plates, driving heads, helmets, and head blocks.

### 185 SLUICE GATES

**Rodney Hunt Machine Co.**—The first basic improvement in sluice gates in many years, the patented HY-Q flush bottom closure sluice gate, is described in Catalog 75. This booklet, with 12 pages of illustrations, clearly shows all details of construction, installation, and operation of the unique gate as used in water filtration plants, power plants, municipal and industrial plants, dry-docks, and flood control.

### 186 SLURRY SEAL

**American Bitumuls & Asphalt Co.**—"Bitumuls Slurry Seal" is an operation which consists of mixing the aggregates with Bitumuls and water to a slurry consistency in a transit mixer, and spreading over the pavement by a specially constructed squeegee type spreader-box. The action of the squeegee forces the slurry into the fine cracks of a weathered but still sound surface of an old asphalt pavement, thereby reducing expensive maintenance patch construction to a minimum.

### 187 SOIL COMPACTION

**Barco Mfg. Co.**—The Vibra-Tamp, a versatile tool for maximum compaction of granular base materials and bituminous surfacing, is the subject of a 4-page bulletin. Whereas the Rammer covers the cohesive type soils where impact compaction is necessary, the Vibra-Tamp covers the non-cohesive type soils where surface finish is desirable. Specifications and on-the-job photos are included in the brochure.

Turn to page 144 and order your literature.


# LABYRINTH® WATERSTOPS

**A SOUND INVESTMENT FOR CONCRETE CONSTRUCTION!**

LABYRINTH AVAILABLE IN 2, 3 or 4 rib.

**ON YOUR CONSTRUCTION:**

**1.** Consider the investment in design, materials and labor (to mention a few).

**2.** Then consider how important safe, secure *watertight* concrete joints are.

**3.** Thorough watertightness *can* be secured by installing Labyrinth Waterstops—a dividend that makes the low initial cost of the product insignificant when compared to your total investment—and one that insures watertight concrete joints for years!

- Corrugated ribs grip concrete, insure an everlasting bond between joints.
- Finest polyvinyl plastic resists chemical action, aging, severe weather.
- Takes just seconds to nail to form . . . easy to cut and splice on location (prefabricated fittings available).
- There's a Water Seal product for every type of concrete work!

If your aim is to stop water seepage, *stop it effectively with Water Seals' Waterstops!*

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# CATALOG DIGESTS

### 188 SOIL COMPACTION

**Vibroflotation Foundation Co.**—Available is a booklet entitled "Soil Compaction by Vibroflotation" which describes the soil consolidation and engineering services of the Vibroflotation Foundation Co. The booklet illustrates the compaction of 8 to 10-ft cylinders of sandy soil to provide a firm foundation of sand for any type of structure. To make sure of complete coverage in a given area, these cylinders are overlapped according to a predetermined pattern under individual loadings or under entire building areas.

### 189 SOIL SAMPLING EQUIPMENT

**Sprague & Henwood, Inc.**—The recently completed 24-page soil sampling bulletin includes a wide selection of samplers to fill all soil sampling needs. In addition to the various samplers described in earlier bulletins, it includes the S & H Vane Shear Tester, the Greer & McClelland Hydraulic Piston Sampler, the S & H Retractable Plug Sampler, and the Harpoon Type Sampler.

### 190 SOIL TESTING DEVICE

**Charles R. Watts Co.**—Full information is available on the Dens-O-Meter, which was developed after years of research by the Department of Highways, State of Washington. It is now in general use for making field density and moisture tests in wide range of soils, including fine, coarse granular base and gravel. It is accurate and fast in small or large holes up to 3 ft deep.

PLEASE BE PATIENT

YOUR REQUESTS TAKE TIME

### 191 SPEED REDUCERS

**The Earle Gear and Machinery Company**—A sixteen-page illustrated catalog, describing speed reducers as applied to operating machinery, particularly bridge machinery, is available. Outlined are specifications service factors, horsepower ratings and dimensions of the particular units illustrated. Gasoline power units are also dealt with in a compact, easy-to-read form. Photographs are shown of actual installations with miniature blueprints included.

### 192 STEEL & ALLOY FABRICATION

**Graver Tank & Mfg. Co., Inc.**—This 4-page folder describes in brief form all the types of steel and alloy tanks and vessels which the company has fabricated and erected recently. Custom craftsmanship is shown serving municipalities and a wide range of industries such as petroleum, chemicals, steel, and atomic energy.

### 193 STEEL BUILDING PRODUCTS

**Macomber, Inc.**—This illustrated booklet has been published for convenient reference in the use and specification of steel building products such as roof decking, nailable joists, V-Beams and V-Girders, V-Bowstring Trusses, and V-Lok Steel Framing.

### 194 STEEL FOR HIGHWAYS

**Bethlehem Steel Company**—This 36-page illustrated booklet, "Steel for Highways," describes the broad range of Bethlehem steel products used in the construction of a modern highway. These include reinforcing bars, bar mats, dowel units, structural steel, wire rope, drill steel, pipe, guard rail and posts, fence and fence posts, sheet piling and bearing piles, culvert sheets, rock anchor bolts, etc.

### 195 STEEL JOISTS

**Steel Joist Institute**—Some of the many advantages offered by SJI-approved open web steel joists are strength, light weight, easy handling and placement, fire and vermin resistance, versatility and adaptability to different architectural designs.

### 196 STEEL JOISTS

**American Bridge Division**—This 40-page steel joist catalog contains complete design information for spans up to 120-ft. Such subjects as design calculations, bridging, properties and dimensions, end details and accessories, load tables, marking systems for ordering, and specifications are clearly and completely covered in this catalog.

### 197 STEEL SHEET PILING

**L. B. Foster Co.**—A 20-page catalog lists the advantages of renting interlocking steel sheet piling and contains specifications for piling sections, as well as corners and connections. Drawings illustrate various types of sheet piling, and data is provided on dimensions, weight, and section modulus. Diagrams showing construction of several types of cofferdams are also included. On-the-job photos illustrate several typical installations.

### 198 STRATAGRAPH

**Edo Corp.**—An illustrated brochure describes the Model 400 Stratagraph, strata penetrating sonar which records, with sharp definition and complete accuracy, formations underlying rivers, lakes and other relatively shallow bodies of water. Sediment, intermediate layers, bed rock and faults are readily distinguished and pictorially shown on permanent chart. The brochure illustrates equipment and typical recordings.

F/S OPTICAL
PLANIMETER
Model 236/A
Eyestrain and parallax in contouring the figure are eliminated by the optical tracer. No need for subtracting the initial reading or adjusting the counting wheel manually.
• Tracing lens providing large magnification
• Zero setting control
• Vernier unit adjustable from .006 to .020 square inches
• Full servicing by factory specialists
F/S offers a complete line of high quality engineering instruments. Ask your nearest dealer or write today for detailed literature.
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*F/S DISTRIBUTORS: The A. Lietz Co., San Francisco and Los Angeles, Calif.—National Blue Print Co., Chicago, Ill.—Watts Instruments, Columbus, Ohio—Geo. F. Muth Co., Inc., Wash., D. C.—CANADA: Instruments 1951 Ltd., Ottawa, Toronto, Regina, Montreal.*

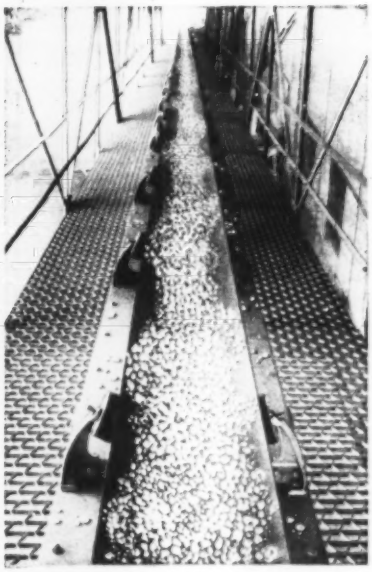
FILOTECNICA

EXHIBITS:

*Texas Surveyors Association*
*Annual Meeting*
*October 6–8, 1958*
**AUSTIN, TEXAS**
*Stephen F. Austin Hotel*
**BOOTH 22/23**

*Civil Engineering Show*
*ASCE Annual Convention*
*October 13–17, 1958*
**NEW YORK CITY**
*Statler Hilton Hotel*
**BOOTH 27**

# STUMBLING HAZARD ELIMINATED



Spilled materials on a solid walkway caused workmen to stumble and turn ankles. Installation of 80% open Irving Mesh Grating allowed materials to fall through and minimized the hazard.

★

*For Safe, Strong, Slip-Proof Stair Treads Specify*

**IRVING "VIZABLEDG" TREADS**

★

*Manufacturers of Riveted, Pressure-Locked, and Welded Gratings of Steel, Aluminum and other metals.*

**"A FITTING GRATING FOR EVERY PURPOSE"**

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***Originators* of the Grating Industry**

**Offices and Plants at**
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**1808 10th St., OAKLAND 23, CALIFORNIA**


## CATALOG DIGESTS

### 199 STRUCTURAL PADS

**Lubrite Div., Merriman Bros., Inc.**—Bulletin No. V-10 contains information and technical data on Vibridge structural pads for bridges. This brochure includes Charts and graphs on Vibridge, physical properties and other important information.

### 200 SURVEY DEPTH RECORDER

**Edo Corp.**—Literature describes and illustrates Model 255 and the Model 255A Survey depth recorders, with sample recordings. Precision sonar equipment for measuring depth of water (0-250 fathoms) with great accuracy, this compact equipment is readily installed on all types of survey vessels. Model 255A, with narrowed beamwidth, records with exceptional detail in relatively small areas.

### 201 SURVEYING EQUIPMENT

**Eugene Dietzgen Company**—Descriptions, illustrations and prices are contained in this 200-page catalog of surveying equipment. A few of the products included are: targets, range poles, leveling rods, theodolites and transits, prismatic compasses, tripods and surveyors' stake hatchets.

### 202 SURVEYING INSTRUMENTS

**C. L. Berger & Sons, Inc.**—A series of descriptive folders illustrating surveying instruments is available. General characteristics are fully described with essential specifications for each instrument.

### 203 SURVEYING INSTRUMENTS

**Charles Bruning Company, Inc.**—Brunson engineering transits and levels, which incorporate patented dustproof ball-bearing construction, are described in a brochure now available. The brochure describes how use of the ball bearing principle prevents costly maintenance, eliminates looseness in bearings, and permits operation in temperatures ranging from 70-deg below zero to 160-deg above zero. It also illustrates various models of instruments.

### 204 SURVEYING INSTRUMENTS

**Fennel Instrument Corp. of America**—Literature is offered containing photographs, as well as detailed descriptions and prices, of the manufacturer's complete line of transits, levels and theodolites for all purposes. Also included is a description of the new planimeter which sets to zero automatically, just by touching a button.

### 205 SURVEYING INSTRUMENTS

**W. & L. E. Gurley**—The complete line of Gurley surveying and engineering instruments, including transits, levels alidades, are described in the revised edition of Catalog 50. Transits described include the Hell Gate Precise Transit; Standard Precise Transit; Gurley Telescopic Solar Transit; Standard Precise Mining Transit; Optoplane Precise Transit for industrial use; Optical Plummet Transit. Included are cross-sectional drawings of many of the transits.

### 206 SURVEYING INSTRUMENTS

**Kern Instruments, Inc.**—A 32-page brochure offers a brief description of the most important instruments manufactured by Kern & Co., Ltd., of Aarau, Switzerland. Fully illustrated, it acts as an index to the detailed literature available on each instrument. Included in the brochure are theodolites, levels, self-reducing tachometers, alidades, pentagonal prisms and many other instruments.

### 207 SURVEY MARKERS

**Copperweld Steel Co.**—This 4-page booklet, in color, lists specifications and describes both types of Copperweld Markers; the bronze head—to be driven flush into paved or even surfaces, and the tinned end—for quick visibility in uneven or heavily-foliaged areas. The pamphlet also includes an explanation of the Molten-Welding process by which the copper and steel in all Copperweld Products are inseparably united.

# HELP for engineers!

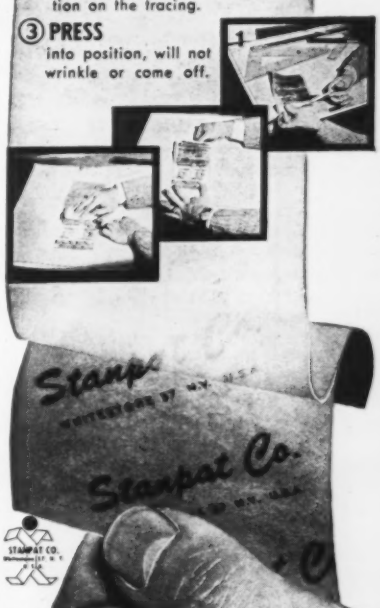
**STANPAT**—the remarkable tri-acetate that is pre-printed with your standard and repetitive blueprint items, easily transferred to your tracings by an adhesive back or front. Relieves time-consuming and tedious detail of re-drawing and re-lettering specification and revision boxes, standard symbols, sub-assemblies, components and cross-sections. Saves hundreds of expensive hours of drafting time and money, frees the engineer for concentration on more creative work.

**so simple to use:**

① **PEEL** the tri-acetate adhesive from its backing.

② **PLACE** the tri-acetate in position on the tracing.

③ **PRESS** into position, will not wrinkle or come off.

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Phone: FLushing 9-1693-1611 Dept. 54

☐ Please quote on enclosed samples.
☐ Kindly send me STANPAT literature and samples.

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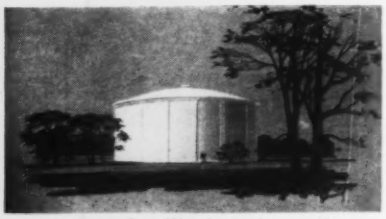
Title_____
Company_____
Address_____

# Prestressed Concrete Tanks Show Big Savings

## Maintenance Costs Cut By 75%

Over a 50 year service life, a prestressed concrete tank will show a 75% saving in total maintenance costs over a steel tank of the same capacity. In today's economy, such a long range saving has tremendous appeal to municipalities and water companies throughout the world. When your tank requirements are in the planning stage, these calculated maintenance costs should be considered. Average yearly maintenance on a 3,000,000 gallon steel tank is estimated at $2500 per year at current prices. For a prestressed concrete tank, maintenance is negligible; however, occasional painting for color effect may be desired.

When the charges for servicing the initial cost plus relative maintenance allowances are plotted, the prestressed



concrete tank will often show a lower out of pocket cost to the owner in less than 5 years. When these costs and their increases are extended for an expected service life of 50 years, the savings to the owner with prestressed concrete are enormous.

The prestressed concrete tank is also a good looking tank . . . it is inherently strong and extremely stable . . . it is designed and built for permanence.

And, 75% of the contract price is spent right in your local community . . . construction is done with materials and labor available locally.

Write today for more information on Preload Prestressed Concrete Tanks

**THE PRELOAD COMPANY, INC.**
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New York 16, New York

**PRELOAD CONCRETE STRUCTURES, INC.**
837 Old Country Rd., Westbury, L. I., N. Y.

**THE PRELOAD COMPANY, INC.**
711 Perimeter Road, Kansas City, Missouri

**HERRICK IRON WORKS**
28400 Clawiter Road, Hayward, California

**THE PRELOAD COMPANY, INC.**
Jefferson Tower Bldg., 351 Jefferson, Dallas, Tex

**THE CANADA GUNITE COMPANY, LTD.**
7325 Decarie Boulevard, Montreal 16, Canada


# CATALOG DIGESTS

### 208 SWIMMING POOLS

**National Pool Equipment Co.**—Residential and commercial catalogs and price lists for the use of all engineers and architects are offered, which describe the company's complete line of swimming pool equipment. Also manufactured and designed is a prestressed concrete pool that is particularly engineered to withstand unusual climatic and soil conditions.

### 209 "T-1" ALLOY STEEL

**United States Steel Corp.**—The most comprehensive collection of facts and data about USS "T-1" constructional alloy steel. Complete data on available sizes, forms, conditions, fabrication, welding and application of this 3-times stronger than structural steel product. Complete properties and characteristics. 64 pages.

### 210 "T-1" STEEL

**Lukens Steel Co.**—A description of Lukens "T-1" steel, its properties, uses, and fabrication techniques is included in a new brochure.

PLEASE PRINT
NAME CLEARLY

### 211 TECHNICAL DATA CATALOG

**Lefax Publishers**—A newly revised catalog for 1958-1959 of Lefax Pocket Size Technical Data Books has been announced. Selling at $1.25 each, these handy books cover every field of engineering and are of constant use to engineers, technical men, surveyors, shopmen, teachers and students. They contain about 140 loose leaf pages of concise, comprehensive, and authoritative material. A partial list includes highway engineering, surveying tables, surveying theory and practice and conversion tables. The catalog will be sent free of charge.

### 212 TELE-PLUMB

**Warren-Knight Co.**—In addition to a cutaway drawing of the Tele-Plumb, instructions on how to use the instrument, and prices, this pamphlet contains a list of special features such as: elimination of the Plumb Bob; nothing to attach or detach between set ups; and can be used on Transits or Transit-Levels. Also includes a description of the Plano-Shift Model 90-S.

### 213 TENNIS COURTS

**American Bitumuls & Asphalt Co.**—"Laykold Tennis Courts" is the title of a 12-page, four-color booklet containing detailed specifications and color photographs of typical installations. There are sections on cost, maintenance, resurfacing and player acceptance. These bituminous courts offer resilient, grit-free, all-weather type surfaces.

### 214 TEREDO CORE DRILL

**Acker Drill Co., Inc.**—will send free of charge a copy of Bulletin #30, which describes the Teredo Core Drill. This unit is ideal for soil sampling and other operations requiring core drilling, and can be supplied either trailer, skid, or truck mounted. Power plant can be either gasoline, kerosine, or diesel engine. Power take off from automotive equipment as well as electric motor or air motor are optional power plants.

### 215 THE COMPLETREATOR

**Dorr-Oliver, Inc.**—An 8-page, two-color bulletin entitled, "The Dorr-Oliver CompleTreator" describes the compact design, operation and advantages of the package-type unit for small plants. Also included in Bulletin #7315, are a line drawing, flow diagram and a series of photographs showing the step-by-step installation of a unit.

### 216 THE EFFECTS OF CALCIUM CHLORIDE

**Solvay Process Division**—This is a 40-page booklet which is of interest to architects, engineers and others concerned with specifications, design or production of cement concrete. The booklet contains a variety of tables, graphs and charts dealing with the setting time, early strength, curing, density, surface wear, shrinkage and ultimate strength. Also shown are effects of varying temperatures and cold weather, and the results with special cements including air-entraining, high early strength and low heat cements.

### 217 TIDE GATES

**Brown & Brown, Inc.**—Literature fully describes a complete line of metal tidal gates in 22 circular sizes and 47 rectangular sizes. Also described are timber gates to meet any requirements and a line of cushioned flap gates for use on pump discharge lines. Dimensional and loss of head data are given.

### 218 TORQUE WRENCH ADAPTER

**P. A. Sturtevant Co.**—Information is available on adapters to extend the range of torque wrenches. Featuring accuracy and economy, the device also provides means of using torque wrench for inverted applications and in areas where clearance does not allow access for the head of the wrench. Interchangeable work drivers increase usefulness at low cost and no modification of the torque wrench is necessary.

### 219 TRAC-HAMMER

**Vulcan Iron Works, Inc.**—Bulletin TH-1 describes and illustrates the Trac-Hammer, which the company developed with Gardner-Denver Co. This versatile machine combines the outstanding features of the Vulcan Portable Pile Hammer and the Gardner-Denver Air-Trac. The unit offers mobility and ease of handling in a type of equipment heretofore requiring cumbersome and expensive prime movers.

***Complete Plant Includes:***

- ★ 75-ton, 3-compartment combination bin
- ★ 3-cu. yd. combination batcher
- ★ 475-Bbl. cement silo
- ★ Cement elevator and screw conveyor
- ★ Aggregate elevator and truck hopper
- ★ All motors and drives

**This is all the plant you need for the Ready-Mix business.**

*Write for complete catalog No. G101*

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## CATALOG DIGESTS

### 220 TRACTOR-SCRAPERS

**Caterpillar Tractor Co.**—Actual job reports showing production and cost for DW15-No. 428 Tractor-Scrapers are featured in a 12-page booklet entitled "Moments of Decision." The features of the DW-15-No. 428 that contribute to faster loading, bigger loads, and higher production are fully explained in the two-color booklet.

### 221 TRACTOR SHOVELS

**Allis-Chalmers Mfg. Co.**—Operating, performance and maintenance advantages provided by HD-16G and HD-21G tractor shovels are told through pictures and story in an 8-page, 2-color catalog now available. Also included are engineering, design and construction features of these two models, which, with aforementioned advantages, provide the big capacity, cost-cutting and versatility users want and demand in their equipment.

### 222 TRANSIT

**Texas-Asiatic Import Co.**—Some of the features of the Eagle Precise 6-in. Transit mentioned in this literature are: all parts except the compass, circle guard, and objective lens outer tube are made of solid bronze; all parts are machined and fitted to very close tolerances to give long service without need for adjustment; and horizontal and vertical circles, verniers, are graduated on heavy sterling silver, slightly oxidized to prevent glare. Specifications are also included.

### 223 TRANSITE PRESSURE PIPE

**Johns-Manville Corp.**—"Transite Pressure Pipe and the Ring-Tite Coupling" is an illustrated, 8-page booklet which describes methods in producing this asbestos-cement pipe for water systems and also describes savings in installation time and outlines characteristic advantages once the pipe is in the ground. Step by step, it gives recommended procedures for installing the pipe and assembling the Ring-Tite Coupling. A table of sizes and classes is included.

### 224 TRANSITE SEWER PIPE

**Johns-Manville Corp.**—"Transite Sewer Pipe with Ring-Tite Coupling" is an 8-page booklet which illustrates and explains economies which this asbestos-cement pipe can effect in the design, installation, operation and maintenance of a sewer system. It shows how the Ring-Tite Coupling makes tight joints more quickly. It covers related items such as the Transite Sewer Pipe Fitting for connecting to Transite building sewer lines. The booklet concludes with a table of sizes, weights and crushing strengths.

### 225 TRAXCAVATORS

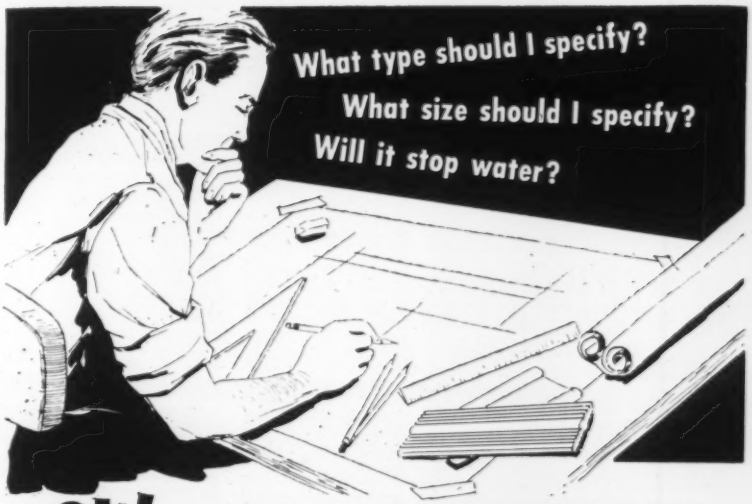
**Caterpillar Tractor Co.**—"Formula For High Production," a new booklet describing Traxcavators and attachments is now available. The 8-page brochure illustrates and describes a wide variety of applications of the Traxcavator line and is available in English, French, Spanish, Portuguese and German.

### 226 TRI-ACETATE SHEETS

**Stanpat Company**—circular describing their printed adhesive-backed acetate sheets for speeding up drafting is available. These sheets are attached to original drawings and save draftsmen from redrawing standard details and repetitive notes. Resulting prints are clear and sharp and save tremendous amount of time.

### 227 TRUCK MIXERS

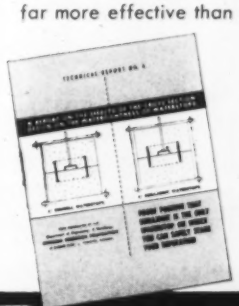
**Construction Machinery Co.**—Some of the many features of Transcrete Truck Mixers which are discussed in this booklet are: automatic drum brake, eliminating kick-back; hard-faced bead weld on blade edge which adds life; self-aligning bearings on all mixer controls eliminating binding; forged alloy steel drum rollers which are fully adjustable; single direction hydraulic shock absorber; and sturdy water tanks with die-formed heads.


NOW...YOU CAN SOLVE YOUR WATERSTOP PROBLEMS IN A SCIENTIFIC MANNER

In the past, smooth surfaced waterstops have been used in concrete structures in the belief that they will effectively eliminate leakages resulting from water percolation around the waterstop. It has been a common practice to specify 6" waterstops for "small jobs" and 9" waterstops for "big jobs" . . . this practice was not based on the results of any scientific analysis. A series of tests have now been conducted by the Ontario Research Foundation in order to determine how the functional performance of DURAJOINT Waterstops, 4" and 6" wide, will compare to the functional performance of Dumbell Type Waterstops, 6" and 9" wide, when embedded in concrete and subjected to hydrostatic pressures of various magnitudes.

The tests provide positive proof that it takes the right combination of PVC material and multiple-ridge cross section design, found only in DURAJOINT, to stop water under all joint conditions that are likely to exist. The tests also proved that the 4" wide DURAJOINT Waterstop is far more effective than the 6" wide Dumbell Waterstop and the 6" DURAJOINT Waterstop is also far more effective than the 9" wide Dumbell Waterstop.



Be sure to investigate these interesting results yourself...send the coupon (below) today, for your free copy of the NEW DURAJOINT Technical Report No. 4. Contains complete technical data, graphic illustrations as to how the performances of waterstops compare, and actual copies of the test reports. If you are interested in waterstops, this report should prove to be one of the most interesting technical manuals you've ever read.

DURAJOINT TECHNICAL INFORMATION Center
121 HILL AVENUE • AURORA, ILLINOIS

Gentlemen: DEPT 20

☐ Please send, without obligation, my free copy of Technical Report No. 4.
☐ DURAJOINT Catalog No. 457.
☐ Have representative call.

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FIRM_____
ADDRESS_____
CITY_____STATE_____

### 228 TUNNEL & MINE EQUIPMENT

**Mayo Tunnel & Mine Equipment**—Newly revised 8-page Bulletin No. 22 shows installation shots of steel forms, head frames, mine cars, couplers, kibbles and gilleys, grouters and many other pieces of equipment for tunnel haulage and mine shaft construction.

### 229 TUNNELS

**Spencer, White & Prentis, Inc.**—"Famous Subways and Tunnels of the World," by Edward and Muriel White recounts the fascinating history of subways and tunnels from earliest times. The price is $2.75.

N. B. There is a charge for this book. Make checks payable to Spencer, White & Prentis, Inc.

### 230 TURBOCHARGED DIESEL POWERED TRACTOR

**Allis-Chalmers Mfg. Co.**—Major advances in design of the HD-21 diesel powered tractor are described in the two-color, 16-page catalog (MS-1243) now available. Photographs and other illustrations point to these features and help tell the engineering and construction story of the tractor. Matched equipment and a line of accessories are also pictured. Tractor specifications are included.

DID YOU MAKE YOUR CHECKS PAYABLE TO THE PROPER COMPANIES? ARE THE AMOUNTS CORRECT?

### 231 TWO COMPACTING UNITS IN ONE

**Galion Iron Works & Mfg. Co.**—Bulletin No. 423 presents Galion's combination 3-Wheel Roller with Jackson Electric Vibratory Compactor. It shows how you get the compressing action of massive roller weight plus the consolidating action of vibration. It is claimed this unit is so effective that density specifications such as Proctor, Modified Proctor, and AASHO-T99-49 are often attained in one pass per lift.

### 232 UNDERPASSES, TUNNELS, CONDUITS

**Armco Drainage & Metal Products, Inc.**—Manual TL-5956 describes and illustrates various types of corrugated metal structures for underpasses, industrial conveyance tunnels and conduits. Sizes and shapes are shown, tables given, and methods of obtaining openings detailed. Another section deals with end treatments, floors and drainage, lighting, brackets and conveying equipment.

### 233 UNDERPINNING

**Spencer, White & Prentis, Inc.**—"Underpinning," a book by Edmund Astley Prentis and Lazarus White is recognized as the authoritative source for information in the field by engineers, architects and contractors all over the world. The price is $10.

N. B. There is a charge for this book. Make checks payable to Spencer, White & Prentis, Inc.

### 234 UNIVERSAL CARRIER

**Otis Distributing Co.**—Two pieces of literature are available which describe the Universal Carrier for car tops. A safe way to carry boats, ladders, and lumber, the carrier has no cups, bolts or ties to mark or scratch the car. Merely snap down the 4 handles and it is ready for any load up to 500 lb.

### 235 VALVE MANUAL

**The Henry Pratt Co.**—This manual includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes the Pratt Valves and operators.

### 236 VALVES & HYDRANTS

**M & H Valve & Fittings Co.**—No. 52 is a 136-page, hard-back, permanently bound catalog with illustrations, dimensions, weights of valves, hydrants and fittings for water works, filtration plants, sewage disposal plants, fire protection systems and industrial uses. It includes related engineering data. M & H products furnished in accordance with standard specifications of AWWA, ASTM and ASA, are also listed and approved by Underwriters and AFM.

### 237 VERTICAL WATER WELL

**Ranney Method Water Supplies, Inc.**—The newest development in the vertical waterwell field is the subject of this brochure. Called the Vertube, it is a natural gravel vertical water well, designed exclusively for low volume users, at low cost. A diagram of the well completes the brochure.

### 238 VESSEL & MECHANICAL EQUIPMENT

**Goslin-Birmingham Mfg. Co.**—Some of the equipment illustrated and discussed in this brochure are: evaporators, rotary filters, flakers, dryers, and heat exchangers. Also shown are several giant castings from the G-B foundry, which were machined in the company's shops and made ready for shipment. Castings up to 100,000 lb are handled readily in the foundry.

### 239 VIBRATORY EQUIPMENT CATALOG

**Jackson Vibrators, Inc.**—Multiple Compactors for maximum consolidation of sub-base courses in macadam construction, fills, etc. Manually guided Compactors for paving blacktop walks, drives, pavement patching, widening, consolidation of granular soils in trenches, close to abutments, concrete floor sub-bases, etc.; Concrete Vibratory Screeds; Vibratory Tubes for Internal and Surface Vibration in Concrete Paving; General Construction Vibrators; Portable Power Plants.

### 240 VIBRO-TAMPER

**The International Vibration Co.**—This pamphlet describes the Vibro-Tamper as having capacities ranging from 250 to 450-cu yd per hr, depending on job conditions. The high-powered vibration and tamping forces are said to penetrate to a depth of 3-ft, resulting in earth compaction, making subbases and earth-support less subject to traffic vibrations. Specifications and photographs are included.

### 241 VISQUEEN FILM

**Visking Co., Div. of Union Carbide Corp.**—Two brochures have been published about Visqueen Film, a lifetime moisture barrier, a pure plastic, virgin polyethylene. A few of the characteristics and advantages of this film are: lifetime protection, flame resistant, light weight, puncture and tear resistance, dust proofing, air resisting, and wide widths up to 32 ft.

### 242 VITRIFIED CLAY PIPE

**Gladding, McBean & Co., Pipe Products Div.**—A 6-page catalog sheet, A.I.A. 29-B-5, has been prepared on Yellow Joint Speed-Seal Mainline, the vitrified clay pipe with factory-made, mechanical-compression joints. In addition to outlining the advantages of using Speed-Seal Mainline, the attractive two-color sheet contains suggested specifications as well as recommendations for installation and handling the pipe.

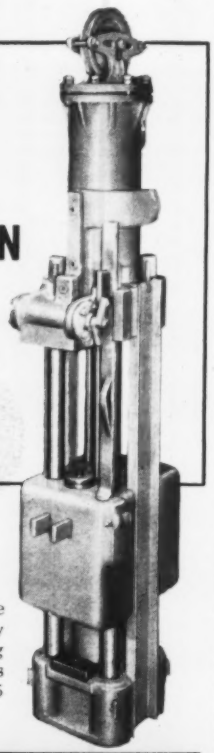

**New Modern Design —Sound Engineering**

*produced this outstanding*

**WARRINGTON—VULCAN**

*Single-Acting*

**STEAM PILE HAMMER**



- Heavy ribs give more support to cylinder head . . .
- Shorter channels permit easier insertion of hammer into leaders . . .

Operating at a medium steam pressure this versatile hammer delivers a moderate frequency of low velocity blows from a relatively heavy ram. A favorite for driving piles of all descriptions. Made in 6 sizes with Rated Striking Energy from 825 ft. lbs. to 30,225 ft. lbs.

*Ask for full information*

**VULCAN IRON WORKS INC.** 327 North Bell Avenue, Chicago 12, Illinois

*Manufacturers of Pile Driving Hammers Since 1852*

# CATALOG DIGESTS

## 243 WAFER VALVES

**S. Morgan Smith Co.**—This catalog describes the new, full-bodied Wafer Valve design. Many of the highly desirable features of two-flanged butterfly valves are incorporated in these rugged metal or rubber-seated valves. Especially applicable to industrial processing, they may be equipped with almost any operator. The catalog gives accurate layout drawings and complete dimensions of all sizes, standard materials used, accessories, engineering data, and layout drawings and dimensions for standard commercial operators generally used with these valves.

## 244 WATER SEWAGE EQUIPMENT

**The Jeffrey Mfg. Co.**—Catalog 905 contains descriptions, diagrams, and photographs of bar and disc type screens, screenings grinders, grit collectors and washers, bucket elevators, sludge draw-off valves, apron, belt and spiral conveyors, chains and sprockets, power transmission machinery, scum removers, and cross collectors.

## 245 WATERSTOP MANUAL

**The Durajoint Technical Information Center**—Contains complete information on Durajoint and Duraseal Polyvinylchloride-PVE Waterstops, for expansion and construction joints. "Durajoint" was specifically compounded and designed for use between adjacent sections of concrete structures. "Durajoint" may be spliced on the job by merely applying heat and holding the ends together until bonded. Requires no welding or vulcanizing equipment.

## 246 WATERSTOP TECH-TIPS AVAILABLE

**Durajoint Technical Information Center**—has ready for distribution, a complete series of Durajoint "Tech-Tips." This series of technical data sheets tells where, why and how to use Durajoint Waterstops. Graphically illustrates how to form-work, install, set-up and how to quickly and easily splice this Waterstop on the job. Covers many applications.

## 247 WATER SUPPLIES

**Ranney Method Water Supplies, Inc.**—"Supplying Water for Municipal and Industrial Use," a 24-page catalog, explains how the Ranney Method can provide any type of water program for these uses. Horizontal collectors, infiltration galleries, vertubes, and intakes are fully described. Photographs and schematics depict each operation.

## 248 WATER WELL DRILLS

**Bucyrus-Erie Co.**—Some of the equipment which this 7-page brochure describes includes the 1-W, smallest in the company's line of water well drills; the 22-W, a medium-size, fast and highly mobile drill; and the 28-L, for drilling larger industrial and municipal wells. The booklet also contains specifications and illustrations.

## 249 WELDED GRATING

**The Globe Co.**—This 8-page bulletin shows details of new lightweight, extra strong Gold Nugget Welded Grating, ideally suitable for power houses, loading docks, oil refineries, fire escapes, drain grates, and all types of heavy duty platforms. General engineering data, safe loading charts, and directions for specifying welded grating are contained in this booklet.

## 250 WELDED & RIVETED GRATINGS

**Klemp Metal Grating Corp.**—A revised 4-page brochure details specifications, safe load tables, diagrams, descriptions, etc., of Klemp welded and riveted gratings. Riv-Dex-teel, Bridge Decking, Drain Grates and varieties of stair treads. Technical drawings indicate installation and applications of these products.

## 251 WELDED WIRE FABRIC

**Laclede Steel Co.**—Information is available on welded wire fabric, which holds resurfacing material securely and reinforces it against creep and surface deterioration. Even at bus stops the movement and gouging of the pavement is minimized.

## 252 WELLPOINT

**Complete Machinery & Equipment Co., Inc.**—This 16-page, illustrated booklet contains four features of the "Complete" Wellpoint, which are: largest screened area of any wellpoint, strongest by the use of fluted tubing, easiest jetting because of lightweight construction, and the ability to lower water further than other points.

## 253 WELLPOINT DEWATERING

**Griffin Wellpoint Corporation**—"The Wellpoint System in Principle and Practice" is a handbook of the fundamentals of wellpoint dewatering and is applicable to any wellpoint system regardless of manufacture. This handbook contains information on how a wellpoint system functions, and methods of planning, layout, installation and removal of the system. The manual is pocket size, 109 pp in length and contains 62 diagrams and illustrations. The price is $1.50.

N. B. There is a charge for this book. Make checks payable to Griffin Wellpoint Corporation.

## 254 WELLPOINT DEWATERING

**Griffin Wellpoint Corp.**—"How to Handle Wet Jobs," a brochure presenting successful solutions to unusual pre-drainage problems is now available.

## 255 WELLPOINT DEWATERING SYSTEM

**Griffin Wellpoint Corporation**—A catalog describes the many items of Griffin wellpoint equipment together with pump capacity charts. It contains a series of actual job photographs showing this equipment on various types of construction projects.

## 256 WELLPOINT SYSTEM

**Moretrench Corporation**—an informative 76-page catalog, fully illustrated, describes the Moretrench wellpoint system and its use in dewatering various types of construction projects. It includes useful technical data on the system.

## 257 WOOD & STEEL TYPE DOORS

**The Kinnear Mfg. Co.**—The catalog and data book discusses fully and illustrates the advantages, the economy, the construction features and the general specifications of the various types of wood and steel upward-acting type doors. Known as Bulletin 96 it gives information on installation, clearance requirements, methods of operation and controls, as well as adaptability of the doors for many types of uses.

## 258 AUTOMATIC CURBER

**E. L. Hardin Associates, Inc.**—This 6-page, illustrated booklet describes the Automatic Curber as a sturdy, simple, portable, and efficient machine, which can lay curb faster without forms using asphaltic or portland cement concrete. Operating and maintenance instructions, and specifications are included.

## 259 CONSTRUCTIONAL TESTING EQUIPMENT

**Tinius Olsen Testing Machine Co.**—Physical testing equipment for constructional materials is described in 12-page Bulletin 55. Details and specifications are given on Laboratory-type Compression Testing Machcines, Super "L" Hydraulic Compression machines with electronic load indication, semi-portable concrete block cylinder and beam testers among other machines and accessories.

## 260 ALUMINUM WELDOR'S TRAINING MANUAL

**Kaiser Aluminum & Chemical Sales, Inc.**—This 144-page booklet contains instructional information designed to train and qualify individuals in welding aluminum by the inert gas process. Free when requested on company letterhead.

N.B. A charge of $1.00 when booklet is for personal use. Make checks payable to Kaiser Aluminum & Chemical Sales, Inc.

THE BRUNTON* POCKET TRANSIT

IT'S HANDY...
weighs only 9 oz.; 2¾" x 3" x 1⅛"; easy to carry in pocket, on belt, in car.

IT'S VERSATILE...
ideal for preliminary and supplementary surveying; used as a compass, transit, level, plumb, alidade, clinometer. Shows direction to 1°; level, slope or grade within 1°.

IT'S MADE TO LAST A LIFETIME
"Over 60,000 Brunton Transits since 1896"

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*in the*
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MORETRENCH
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World's Oldest . . . Largest . . .
Most Experienced
Predrainage Organization

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# PROCEEDINGS AVAILABLE

## September

**Journals:** Irrigation and Drainage, Structural, Waterways and Harbors, Sanitary.

**1750. Potential Use of Water by Irrigation in the Humid Areas, by Keith H. Beauchamp.** (IR) This paper examines the problems of increasing irrigation water demands. Aspects of humid area irrigation offsetting uneven rainfall distribution and stabilizing production and income are presented.

**1751. Worldwide View of Irrigation Developments, by N. D. Gulhati.** (IR) The development of water resources to provide irrigation facilities, improve existing agriculture, and to reclaim large areas of desert or otherwise barren lands are presented.

**1752. Multiple-Use Projects in Development of Water Resources, by W. A. Dexheimer.** (IR) Doubling the United States present water supply by 1975 requires cooperative and multiple-purpose planning. River-basin construction should be coordinated by local, state, and federal agencies.

**1753. State Versus Federal Control of Western Waters, by Lewis A. Stanley.** (IR) Examined in this paper is the Supreme Court decision in the Pelton Dam case as it affects the sovereignty of the western states in the control of nonnavigable waters within their borders.

**1754. Water—A Limiting Resource? by Robert O. Thomas.** (IR) This paper emphasizes the magnitude of the anticipated demand for water in the United States. The availability of water is compared with the major demands made upon the supply.

**1755. Thermal Considerations in the Design of Concrete Shields, by Harold S. Davis.** (ST) Behavior and properties of concrete structures for shielding atomic power plants are presented, with methods for estimating thermal effects associated with linear and non-linear distribution of temperature, nuclear heating, and shield cooling.

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# Index To Advertisers


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Allis-Chalmers Manufacturing Company . . . . . 16 and 103
Aluminum Company of America . . . . . 38 and 39
American Bitumuls & Asphalt Company . . . . . 5
American Bridge Division . . . . . 14, 15, 123, 124 and 125
American Cast Iron Pipe Co. . . . . 114
American-Marietta Company . . . . . 40
American Pipe and Construction Co. . . . . 7
American Steel & Wire Division of United States Steel Corporation . . . . . 22, 23, 124, 124 and 125
Armco Drainage & Metal Products, Inc. . . . . 127
Bethlehem Steel Company . . . . . 147
Bludworth Marine . . . . . 151
Borden Metal Products Co. . . . . 2
Brown & Brown, Inc. . . . . 143
Cast Iron Pipe Research Association . . . . . 26 and 27
Chicago Bridge & Iron Company . . . . . 6
Clipper Manufacturing Co. . . . . 153
Concrete Reinforcing Steel Institute . . . . . 131 and 165
Columbia-Geneva Steel Division 8, 9, 22, 23, 123, 124, 125, 134 and 135
Consolidated Western Steel Division . . . . 123, 124 and 125
Eugene Dietzgen Co. . . . . 143
Dorr-Oliver Incorporated . . . . . 154
E. I. du Pont de Nemours & Co. (Inc.) . . . . . 37
The Earle Gear & Machine Co. . . . . 143
Eastman Kodak Company . . . . . 101
Edo Corporation . . . . . 148
Electrovert, Ltd. . . . . 169
Filotecnica, Salmoiraghi Inc. . . . . 166
Forney's Inc., Tester Division . . . . . 155
Franki Foundation Company . . . . . 31
Gahagan Dredging Corp. . . . . 155
Graver Tank & Mfg. Co., Inc. . . . . 162
M. Greenberg's Sons . . . . . 151
L. O. Gregory Manufacturing, Inc. . . . . 168
E. L. Hardin Associates, Inc. . . . . 126
Haven-Busch Company . . . . . 32
Rodney Hunt Machine Co. . . . . 136
Imperial Tracing Cloth . . . . . 160
Irving Subway Grating Co., Inc. . . . . 167
Kern Instruments Inc. . . . . 162
Kerrigan Iron Works, Inc. . . . . 128 and 129
Keuffel & Esser Co. . . . . 105
Laclede Steel Co. . . . . 145
The James Leffel & Co. . . . . 13
Lehigh Portland Cement Company . . . . . 109
Lenker Manufacturing Company . . . . . 155
Leupold & Stevens Instruments, Inc. . . . . 146
The Lincoln Electric Company . . . . . 121
Lock Joint Pipe Co. . . . . 4th cover
Lone Star Cement Corporation . . . . . 44
Lukens Steel Company . . . . . 139
M & H Valve and Fittings Company . . . . . 157
Macco Corporation . . . . . 1
The Master Builders Co. . . . . 3rd cover
Mayo Tunnel and Mine Equipment . . . . . 159
Moretrench Corporation . . . . . 171
National Tube Division . . . . . 123, 124 and 125
Naylor Pipe Company . . . . . 30
Newport News Shipbuilding and Dry Dock Company . . . . . 20
Ozalid, Division of General Aniline & Film Corporation . . . . . 115
Phoenix Bridge Company . . . . . 165
Pipe Linings Inc. . . . . 160
Pittsburgh-Des Moines Steel Co. . . . . 42
Portland Cement Association . . . . . 33 and 137
Posey Iron Works, Inc. . . . . 163
Henry Pratt Co. . . . . 12
Precision Instruments, Inc. . . . . 132
The Preload Company, Inc. . . . . 168
The Prescon Corporation . . . . . 34
Pressure Concrete Co. . . . . 158
Ranney Method Water Supplies, Inc. . . . . 153
Raymond Concrete Pile Co. . . . . 2nd cover
Rockwell Standard Corporation, Grating Division . . . . . 164
John A. Roebling's Sons Corporation . . . . . 25
Safe-Lock, Inc. . . . . 152
Sika Chemical Corporation . . . . . 10
Smith & Loveless, Inc. . . . . 24
L. Sonneborn Sons, Inc. . . . . 29
Sonoco Products Company . . . . . 149
South Bend Division Curtiss-Wright Corporation . . . . . 110 and 111
Spencer, White & Prentis Inc. . . . . 138
Sprague & Henwood, Inc. . . . . 21
J. S. Staedtler, Inc. . . . . 113
Stanpat Company . . . . . 167
Sverdrup & Parcel Inc. . . . . 141
Superior-Lidgerwood-Mundy Corporation . . . . . 156
Tennessee Coal & Iron Division 8, 9, 22, 23, 123, 124, 125, 134 and 135
The Texas Company . . . . . 133
The Union Metal Manufacturing Co. . . . . 17
U. S. Pipe and Foundry Company . . . . . 18 and 19
United States Steel Corporation 8, 9, 14, 15, 22, 23, 106, 107, 123, 124, 125, 134 and 135
United States Steel Export Company 8, 9, 14, 15, 22, 23, 134 and 135
United States Steel Supply Division . . 8, 9, 123, 124 and 125
Universal Atlas Cement Division of United States Steel Corporation . . . . . 123, 124 and 125
Universal Form Clamp Co. . . . . 28
Vibroflotation Foundation Co. . . . . 161
Vulcan Iron Works Inc. . . . . 170
Water Seals, Inc. . . . . 165
Wild Heerbrugg Instruments, Inc. . . . . 35
R. D. Wood Company . . . . . 4
Yuba Manufacturing Division, Yuba Consolidated Industries, Inc. . . . . 11
Zimmer & Francescon . . . . . 36
Professional Services . . . . . 174, 175, 176 and 177



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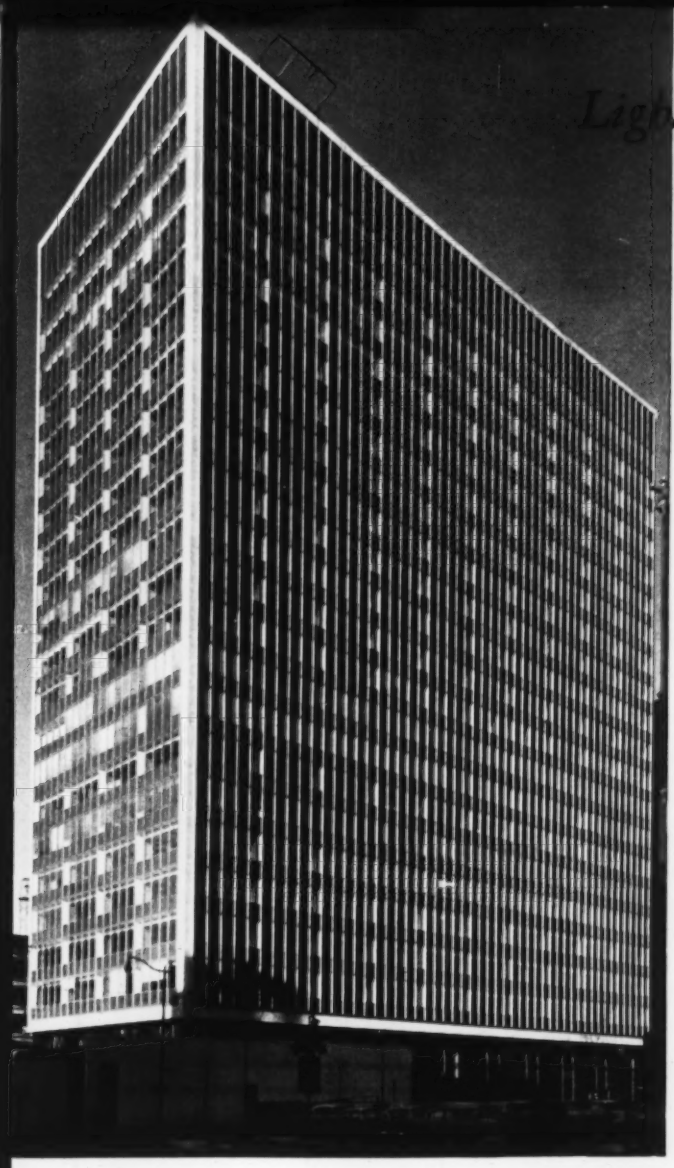

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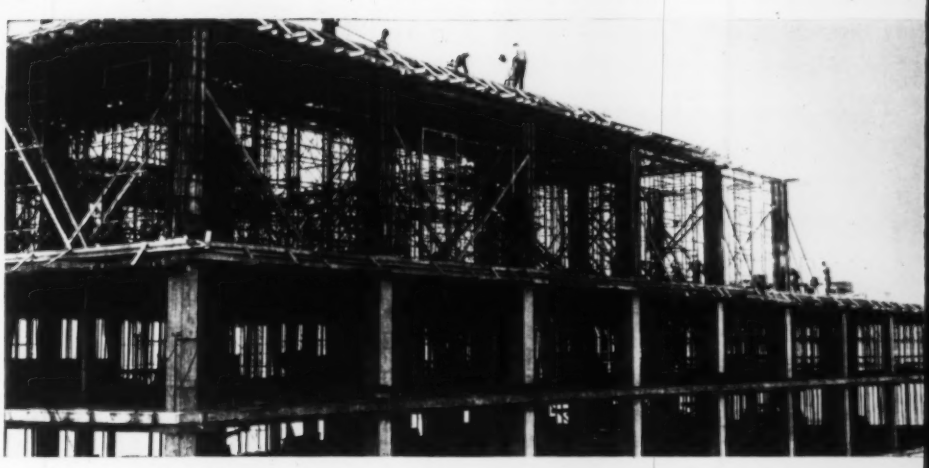

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